Switch 8800 Configuration Guide

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3Com Corporation
350 Campus Drive
Marlborough, MA
01752-3064

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CONTENTS

ABOUT THIS GUIDE

Conventions 1

SYSTEM ACCESS

Product Overview 3
- Function Features 3

Configuring the Switch 8800 4

Setting Terminal Parameters 5
- Configuring Through Telnet 7
- Configuring Through a Dial-up Modem 10
- Configuring the User Interface 11

Command Line Interface 19
- Command Line View 19
- Features and Functions of the Command Line 22

PORT CONFIGURATION

Ethernet Port Overview 27
- Configuring Ethernet Ports 27
- Example: Configuring the Default VLAN ID of the Trunk Port 34
- Troubleshooting VLAN Port Configuration 34

Configuring Link Aggregation 34
- Load Sharing 35
- Port State 36
- Configuring Link Aggregation 36
- Example: Link Aggregation Configuration 38

VLAN CONFIGURATION

VLAN Overview 39

Configuring VLANs 39
- Common VLAN Configuration Tasks 39
- Adding Ethernet Ports to a VLAN 40

Configuring GARP/GVRP 42
- Configuring GVRP 44

NETWORK PROTOCOL OPERATION

Configuring IP Address 49
- Subnet and Mask 50
- Configuring an IP Address 50
- Troubleshooting an IP Address Configuration 52

Configuring Address Resolution Protocol (ARP) 52
- Configuring ARP 52

DHCP Relay 54
- Configuring DHCP Relay 55
- Troubleshooting a DHCP Relay Configuration 58

IP Performance 59
- Configuring TCP Attributes 59
- Displaying and Debugging IP Performance 59
- Troubleshooting IP Performance 60

IPX Configuration 61
- IPX Address Structure 61
- Routing Information Protocol 61
- Service Advertising Protocol 61

IP ROUTING PROTOCOL OPERATION

IP Routing Protocol Overview 63
- Selecting Routes Through the Routing Table 64
- Routing Management Policy 65

Static Routes 67
- Configuring Static Routes 68
- Troubleshooting Static Routes 71

RIP 71
- Configuring RIP 72
- Troubleshooting RIP 81

OSPF 81
- Calculating OSPF Routes 81
- Configuring OSPF 84
- Troubleshooting OSPF 103

IS-IS 105
- Two-Level Structure of IS-IS 105
- NSAP Structure of IS-IS 107
- IS-IS Packets 108
- Configuring Integrated IS-IS 109
- Integrated IS-IS Configuration Example 123

BGP 125
- BGP Messages 126
- BGP Routing 126
- BGP Peers and Peer Groups 127
- Configuring BGP 127
- Typical BGP Configuration Examples 145
- Troubleshooting BGP 151

IP Routing Policy 151
Routing Information Filters 152
Configuring an IP Routing Policy 153
Troubleshooting Routing Policies 159
Route Capacity 159
Limiting Route Capacity 160
Configuring Route Capacity 160

MULTICAST PROTOCOL

IP Multicast Overview 167
Multicast Addresses 168
IP Multicast Protocols 170
Forwarding IP Multicast Packets 171
Applying Multicast 172
Configuring Common Multicast 172
Configuring Common Multicast 172
Configuring IGMP 174
Configuring IGMP 175
IGMP Snooping 181
Configuring IGMP Snooping 184
IGMP Snooping Configuration Example 186
Troubleshooting IGMP Snooping 186
Configuring PIM-DM 187
Configuring PIM-DM 188
PIM-DM Configuration Example 191
Configuring PIM-SM 192
PIM-SM Operating Principles 193
Preparing to Configure PIM-SM 194
Configuring PIM-SM 195
GMRP 203
Configuring GMRP 204

QOS/ACL OPERATION

ACL Overview 207
ACLs Activated Directly on Hardware 207
ACLs Referenced by Upper-level Modules 207
ACLs Supported 208
Configuring ACLs 208
Configuring Time Range 209
Defining and Applying a Flow Template 209
Defining ACLs 211
Activating ACLs 212
Displaying and Debugging ACL Configurations 213
ACL Configuration Example 213
Basic ACL Configuration Example 214
L2 ACL Configuration Example 215

QoS Configuration 216
QoS Configuration 219
Configuration Examples 229
Traffic Policing Configuration Example 229
Traffic Shaping Configuration Example 231
Port Mirroring Configuration Example 231
Traffic Priority Configuration Example 232
Traffic Redirection Configuration Example 233
Queue Scheduling Configuration Example 234
WRED Parameters Configuration Example 235
Traffic Statistics Configuration Example 235
Configuring Logon User ACL Control 236
Configuring ACL for Telnet Users 236
Configuration Example 237
Configuring ACL for SNMP Users 238
Configuration Example 239

STP OPERATION

STP Overview 241
Configuring STP 241
Designating Switches and Ports 242
Calculating the STP Algorithm 242
Generating the Configuration BPDU 243
Selecting the Optimum Configuration BPDU 243
Designating the Root Port 243
Configuring the BPDU Forwarding Mechanism 245
MSTP Overview 246
MSTP Concepts 246
MSTP Principles 249
Configuring MSTP 249
Configuring the MST Region for a Switch 250
Specifying the Switch as Primary or Secondary Root Switch 251
Configuring the MSTP Operating Mode 252
Configuring the Bridge Priority for a Switch 253
Configuring the Max Hops in an MST Region 253
Configuring the Switching Network Diameter 254
Configuring the Time Parameters of a Switch 255
Configuring the Max Transmission Speed on a Port 256
Configuring a Port as an Edge Port 257
Configuring the Path Cost of a Port 257
Configuring the Priority of a Port 259
Configuring the Port Connection with the Point-to-Point Link 260
Configuring the mCheck Variable of a Port 261
Configuring the Switch Security Function 262
Enabling MSTP on the Device 263
Enabling or Disabling MSTP on a Port 263
Displaying and Debugging MSTP 264

AAA and RADIUS Operation

IEEE 802.1x 265
- 802.1x System Architecture 265
- Configuring 802.1x 267

Configuring the AAA and RADIUS Protocols 274
- Configuring AAA 276
- Configuring the RADIUS Protocol 279
- Troubleshooting AAA and RADIUS 289

Reliability

VRRP Overview 291

Configuring VRRP 292
- Enable Pinging the Virtual IP Address 292
- Setting Correspondence Between Virtual IP and MAC Addresses 293
- Adding and Deleting a Virtual IP Address 293
- Configuring the Priority of Switches 294
- Configuring Preemption and Delay for a Switch 294
- Configuring Authentication Type and Authentication Key 295
- Configuring the VRRP Timer 295
- Configuring a Switch to Track an Interface 296
- Displaying and Debugging VRRP 296
- Troubleshooting VRRP 299

System Management

File System 301
- Using a Directory 301
- Managing Files 302
- Formatting Storage Devices 302
- Setting the Prompt Mode of the File System 302
- Configuring File Management 303
- FTP 304
- TFTP 306

Managing the MAC Address Table 307
- Configuring the MAC Address Table 308

Managing Devices 312
- Rebooting the Switch 8800 312
- Designating the File for the Next Boot 312
- Displaying Devices 313

Maintaining and Debugging the System 313
- Configuring System Basics 314
- Displaying System Information and State 315
- Debugging the System 315
- Testing Tools for Network Connection 317
- Logging Function 318

SNMP 322

SNMP Versions and Supported MIB 322
Configuring SNMP 323
RMON 329
Configuring RMON 330
NTP 333
Configuring NTP 335
NTP Configuration Examples 341

About This Guide

This guide describes the 3Com® Switch 8800 and how to configure it in version 3.0 of the software.

Conventions

Table 1 lists icon conventions that are used throughout this book.

Table 1 Notice Icons

Icon	Notice Type	Description
	Information note	Information that describes important features or instructions.
	Caution	Information that alerts you to potential loss of data or potential damage to an application, system, or device.
	Warning	Information that alerts you to potential personal injury.

Table 2 lists the text conventions used in this book.

Table 2 Text Conventions

Convention	Description
Screen displays	This typeface represents information as it appears on the screen.
Keyboard key names	If you must press two or more keys simultaneously, the key names are linked with a plus sign (+), for example:
Press Ctrl+Alt+Del	The words "enter" and type"
When you see the word "enter" in this guide, you must type something, and then press Return or Enter. Do not press Return or Enter when an instruction simply says "type."	Words in *italics*
Italics are used to:	Emphasize a point.
Denote a new term at the place where it is defined in the text.	Identify command variables.
Identify menu names, menu commands, and software button names. Examples:	From the *Help* menu, select *Contents*.
Click *OK*.	Words in **bold**
Boldface type is used to highlight command names. For example, "Use the **display user-interface** command to..."	

1 SYSTEM ACCESS

This chapter covers the following topics:

- Product Overview
- Configuring the Switch 8800
- Setting Terminal Parameters
- Command Line Interface

Product Overview

The 3Com Switch 8800 is a large capacity, modular wire speed Layer 2/Layer 3 switch. It is designed for IP metropolitan area networks (MAN), large-sized enterprise networks, and campus network users.

The Switch 8800 has an integrated chassis structure. The chassis contains a I/O module area, fan area, power supply area, and a power distribution area. In the I/O module area, there are seven, ten, or fourteen slots. Two slots are reserved for the switch Fabric modules, and the remaining slots are for the I/O modules. You can install different interface modules for different networks; the slots support a mixed set of modules.

The Switch 8800 supports the following services:

- MAN, enterprise/campus networking
- Multicast service and multicast routing functions and support audio and video multicast service.

Function Features

Table 1 lists and describes the function features that the Switch 8800 supports.

Table 1 Function Features

Features	Support
VLAN	VLANs compliant with IEEE 802.1Q standard Port-based VLAN GARP VLAN Registration Protocol (GVRP)
STP protocol	Spanning Tree Protocol (STP) Rapid Spanning Tree Protocol (RSTP) Multiple Spanning Tree Protocol (MSTP), compliant with IEEE 802.1D/IEEE 802.1s Standard
Flow control	IEEE 802.3x flow control (full-duplex) Back-pressure based flow control (half-duplex)
Broadcast suppression	Broadcast suppression
Multicast	GARP Multicast Registration Protocol (GMRP) Internet Group Management Protocol (IGMP) Snooping Internet Group Management Protocol (IGMP) Protocol-Independent Multicast-Dense Mode (PIM-DM) Protocol-Independent Multicast-Sparse Mode (PIM-SM)

Table 1 Function Features (continued)

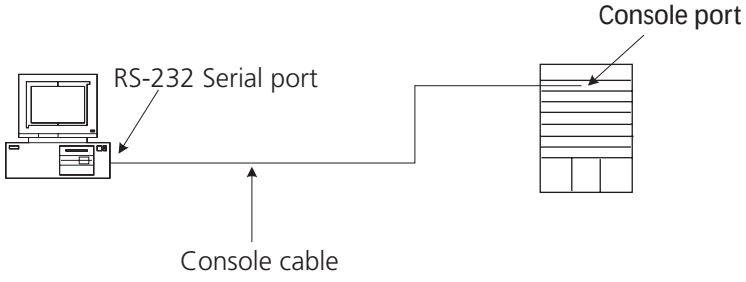
Features	Support
IP routing	Static route RIP v1/v2 OSPF BGP (in advanced software) IS-IS (in advanced software) IP routing policy
DHCP Relay	Dynamic Host Configuration Protocol (DHCP) Relay
Link aggregation	IEEE 802.3ad Link aggregation
Mirror	Port-based mirroring (one to one, many to one)
Security features	Multi-level user management and password protect 802.1X authentication Radius authentication Packet filtering
Reliability	Virtual Redundancy Routing Protocol (VRRP)
Quality of Service (QoS)	Traffic classification Bandwidth control Priority Queues of different priority on the port Queue scheduling: supports strict priority (SP), weighted round robin (WRR), committed access route (CAR) queueing
Management and maintenance	Command line interface configuration Configuration through the console and AUX ports Local or remote configuration by Telnet Remote configuration by dialing the modem through the AUX port SNMP System log Level alarms Output of the debugging information PING and Tracert Remote maintenance with Telnet and modem
Loading and updating	Loading and upgrading software using the XModem protocol Loading and upgrading software using the File Transfer Protocol (FTP) and Trivial File Transfer Protocol (TFTP)

Configuring the Switch 8800

On the Switch 8800, you can set up the configuration environment through the console port. To set up the local configuration environment:

1. Plug the DB-9 or DB-25 female plug of the console cable into the serial port of the PC or the terminal where the switch is to be configured.
2. Connect the RJ-45 connector of the console cable to the console port of the switch, as shown in Figure 1.

Figure 1 Setting Up the Local Configuration Environment Through the Console Port



Setting Terminal Parameters

To set terminal parameters:

1. Start the PC and select *Start* > *Programs* > *Accessories* > *Communications* > *HyperTerminal*.
2. The HyperTerminal window displays the Connection Description dialog box, as shown in Figure 2.

Figure 2 Set Up the New Connection

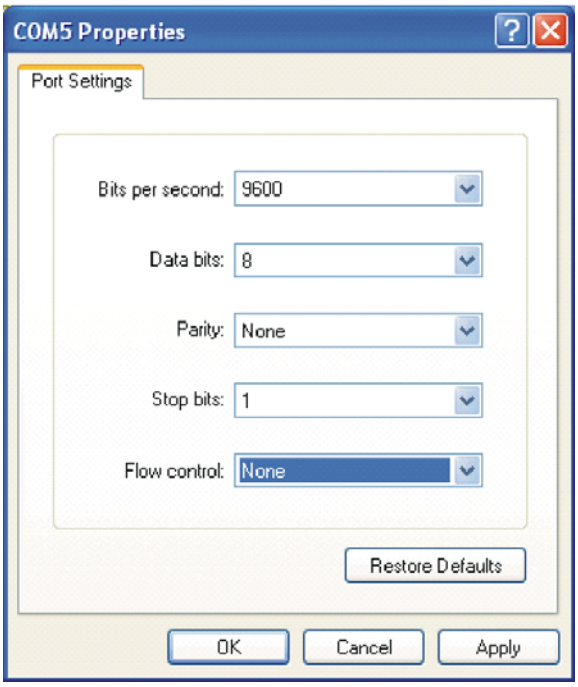
3. Enter the name of the new connection in the *Name* field and click *OK*. The dialog box, shown in Figure 3 displays.
4. Select the serial port to be used from the *Connect using* dropdown menu.

Figure 3 Properties Dialog Box

5 Click *OK*. The Port Settings tab, shown in Figure 4, displays and you can set serial port parameters. Set the following parameters:

- Baud rate = 9600
- Databit = 8
- Parity check = none
- Stopbit = 1
- Flow control = none

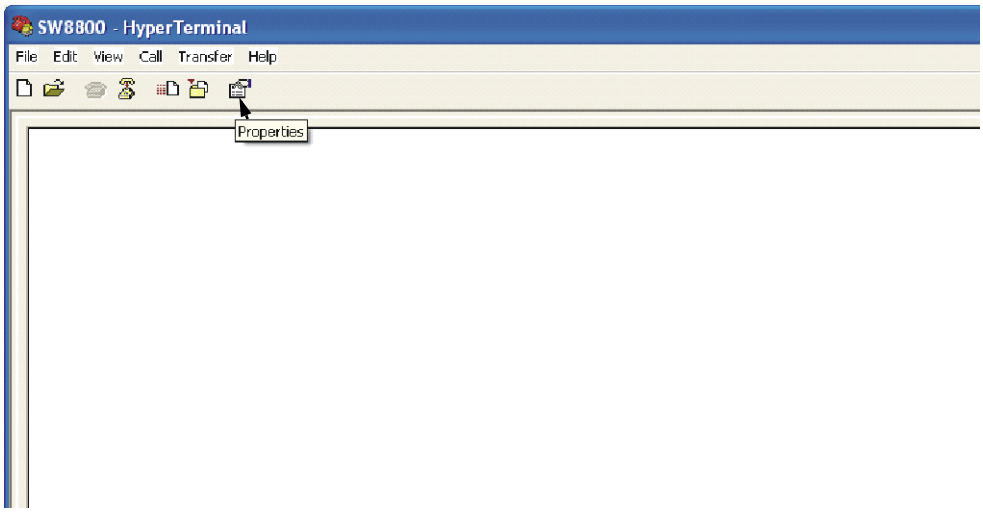
Figure 4 Set Communication Parameters



6 Click *OK*. The HyperTerminal dialogue box displays, as shown in Figure 5.

7 Select *Properties*.

Figure 5 HyperTerminal Window

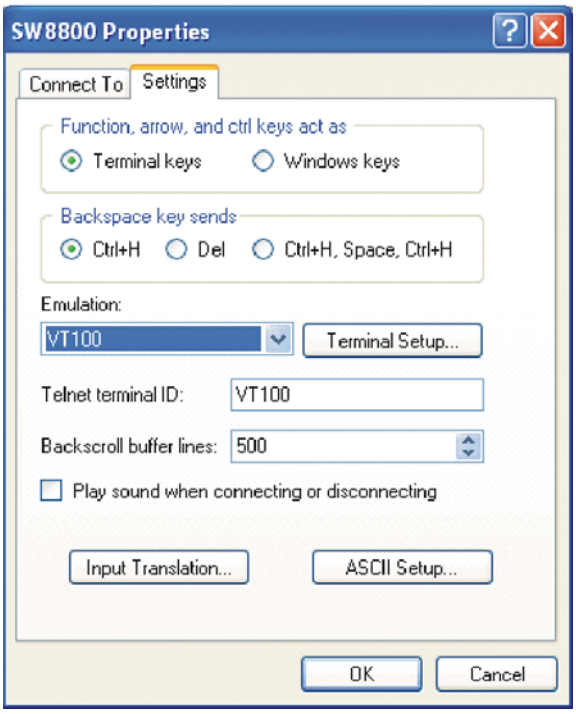


8 In the Properties dialog box, select the *Settings* tab, as shown in Figure 6.

9 Select *VT100* in the *Emulation* dropdown menu.

10 Click *OK*.

Figure 6 Settings Tab



Setting the Terminal Parameters is described in the following sections:

- Configuring Through Telnet
- Configuring Through a Dial-up Modem
- Configuring the User Interface

Configuring Through Telnet

Before you can telnet to a Switch 8800 and configure it, you must:

1 Configure the IP address of a VLAN interface for the Switch 8800 through the console port (using the **ip address** command in VLAN interface view)

2 Add the port (that connects to a terminal) to this VLAN (using the **port** command in VLAN view)

3 Log in to the Switch 8800

Tasks for Configuring through Telnet are described in the following sections:

- Connecting the PC to the Switch 8800
- Connecting Two Switch 8800 Systems

Connecting the PC to the Switch 8800

To connect the PC and Switch 8800 through Telnet:

1 Authenticate the Telnet user through the console port before the user logs in by Telnet.

By default, a password is required for authenticating the Telnet user to log in the Switch 8800. If a user logs in by Telnet without a password, the user sees the message: `Login password has not been set!`

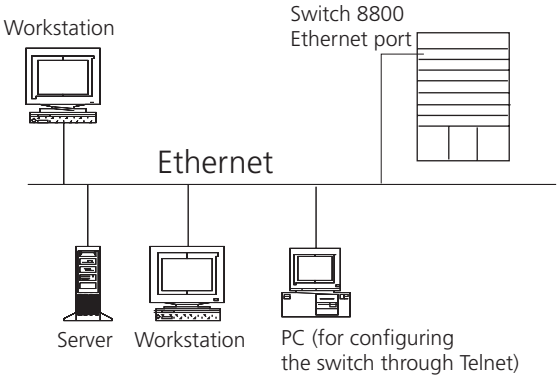
2 Enter system view, return to user view by pressing *Ctrl*+Z.

```
<SW8800>system-view
[SW8800]user-interface vty 0 4
[SW8800-ui-vty0]set authentication password simple/cipher xxxx
```

(xxxx is the preset login password of Telnet user)

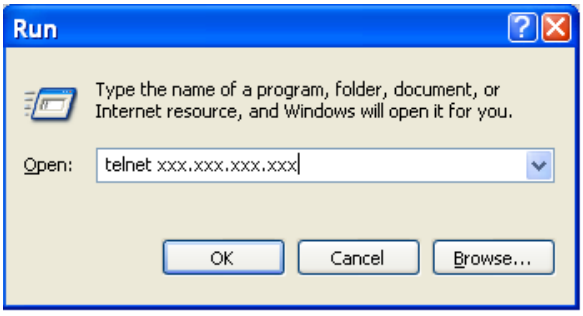
3 To set up the configuration environment, connect the Ethernet port of the PC to that of the Switch 8800 through the LAN. See Figure 7.

Figure 7 Setting Up the Configuration Environment Through Telnet



4 Run Telnet on the PC by selecting *Start* > *Run* from the Windows desktop and entering *Telnet* in the *Open* field, as shown in Figure 8. Click *OK*.

Figure 8 Run Telnet



The terminal displays *User Access Verification* and prompts you for the logon password.

5 Enter the password. The terminal displays the command line prompt (`<SW8800>`).

If the message, `Too many users!` appears, try to reconnect later. At most, 5 Telnet users are allowed to log on to a Switch 8800 simultaneously.

6 Use the appropriate commands to configure the Switch 8800 or to monitor the operational state. Enter **?** to get immediate help. For details on specific commands, refer to the chapters in this guide.

When configuring the Switch 8800 by Telnet, do not modify the IP address unless necessary, because the modification might terminate the Telnet connection. By default, after passing the password authentication and logging on, a Telnet user can access the commands at login level 0.

Connecting Two Switch 8800 Systems

Before you can telnet the Switch 8800 to another Switch 8800, as shown in Figure 9, you must:

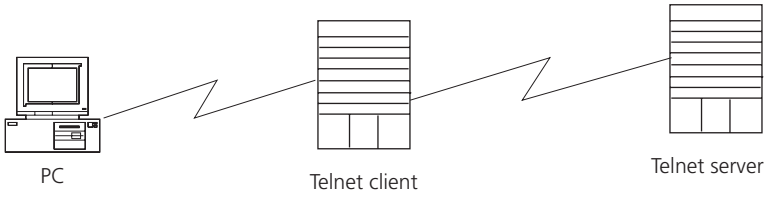
1 Configure the IP address of a VLAN interface for the Switch 8800 through the console port (using the **ip address** command in VLAN interface view)

2 Add the port (that connects to a terminal) to this VLAN (using the **port** command in VLAN view)

3 Log in to the Switch 8800

After you telnet to a Switch 8800, you can run the **telnet** command to log in and configure another Switch 8800.

Figure 9 Provide Telnet Client Service



1 Authenticate the Telnet user through the console port on the Telnet Server (Switch 8800) before login.

By default, a password is required for authenticating the Telnet user to log in the Switch 8800. If a user logs into Telnet without password, the system displays the following message: `Login password has not been set!`

2 Enter system view, return to user view by pressing *Ctrl+Z*.

```
<SW8800>system-view
[SW8800]user-interface vty 0
[SW8800-ui-vty0]set authentication password simple/cipher xxxx (xxxx
is the preset login password of Telnet user)
```

3 Log in to the Telnet client (Switch 8800). For the login process, see "Connecting the PC to the Switch 8800".

4 Perform the following operations on the Telnet client:

```
<SW8800>telnet xxxx
```

(XXXX can be the hostname or IP address of the Telnet Server. If it is the hostname, you need to use the **ip host** command to specify it).

5 Enter the preset login password. The Switch 8800 prompt (`<SW8800>`) displays. If the message, `Too many users!` displays, try to connect later.

6 Use the appropriate commands to configure the Switch 8800 or view its operational state. Enter **?** to get immediate help. For details on a specific command, refer to the appropriate chapter in this guide.

Configuring Through a Dial-up Modem

To configure your router with a dial-up modem through the AUX port:

1 Authenticate the modem user through the console port of the Switch 8800 before the user logs in to the switch through a dial-up modem.

By default, a password is required for authenticating the modem user to log in to the Switch 8800. If a user logs in through the modem without a password, the user sees the message, `Password required, but none set.`

a Enter system view, return user view with *Ctrl+Z*.

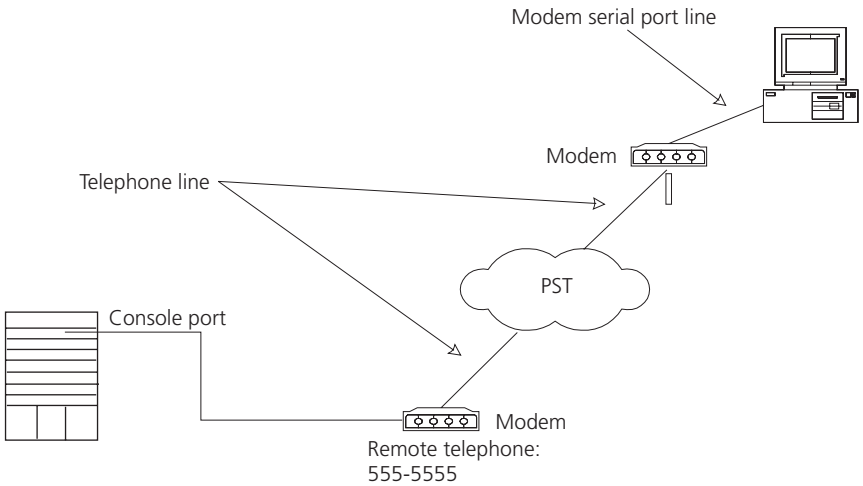
```
<SW8800>system-view
[SW8800]user-interface aux 0
[SW8800-ui-aux0]set authentication password simple/cipher xxxx (xxxx
is the preset login password of the Modem user.)
```

b Using the **modem** command, you can configure the console port to modem mode.

```
[SW8800-ui-aux0]modem
```

2 To set up the remote configuration environment, connect the modems to a PC (or a terminal) serial port and to the Switch 8800 console port, as shown in Set Up Remote Configuration Environment.

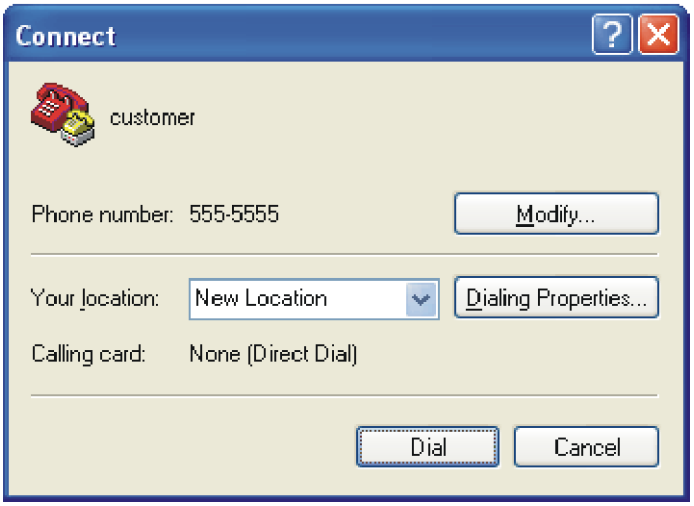
Figure 10 Set Up Remote Configuration Environment



3 Dial for a connection to the switch, using the terminal emulator and modem on the remote end. Dial the telephone number of the modem connected to the Switch 8800. See Figure 11 and Figure 12.

Figure 11 Set the Dialed Number

Figure 12 Dial the Remote PC



4 Enter the preset login password on the remote terminal emulator and wait for the `<SW8800>` prompt.

5 Use the appropriate commands to configure the Switch 8800 or view its operational state. Enter **?** to get immediate help. For details on a specific command, refer to the appropriate chapter in this guide.

By default, after login, a modem user can access the commands at Level 0.

Configuring the User Interface

User interface configuration is another way to configure and manage port data.

The Switch 8800 supports the following configuration methods:

- Local configuration through the console port
- Remote configuration through Telnet on the Ethernet port

- Remote configuration through a modem through the console port.

There are two types of user interfaces:

- AUX user interface is used to log in the Switch 8800 through a dial-up modem. A Switch 8800 can only have one AUX port.
- VTY user interface is used to telnet the Switch 8800.

For the Switch 8800, the AUX port and Console port are the same port. There is only the type of AUX user interface.

The user interface is numbered by absolute number or relative number.

To number the user interface by absolute number:

- The AUX user interface is the first interface — user interface 0.
- The VTY is numbered after the AUX user interface. The absolute number of the first VTY is the AUX user interface number plus 1.

To number the user interface by relative number, represented by *interface* + *number* assigned to each type of user interface:

- AUX user interface = AUX 0.
- The first VTY interface = VTY 0, the second one = VTY 1, and so on.

Tasks for configuring the user interface are described in the following sections:

- Entering the User Interface View
- Configuring the Attributes of the AUX (Console) Port
- Configuring the Terminal Attributes
- Managing Users
- Configuring the Attributes of a Modem
- Configuring Redirection
- Displaying and Debugging User Interface

Entering the User Interface View

Use the **user-interface** command (see Table 2) to enter a user interface view. You can enter a single user interface view or multi-user interface view to configure one or more user interfaces.

Perform the following configuration in system view.

Table 2 Enter User Interface View

Operation	Command
Enter a single user interface view or multi user interface views	**user-interface** [*type*] *first-number* [*last-number*]

Configuring the Attributes of the AUX (Console) Port

Use the **speed**, **flow control**, **parity**, **stop bit**, and **data bit** commands (see Table 3) to configure these attributes of the AUX (Console) port.

Perform the following configurations in user interface (AUX user interface only) view.

Table 3 Configure the Attributes of the AUX (Console) Port

Operation	Command
Configure the transmission speed on AUX (Console) port. By default, the transmission speed is 9600bps	**speed** *speed-value*
Restore the default transmission speed on AUX (Console) port	**undo speed**
Configure the flow control on AUX (Console) port. By default, no flow control is performed on the AUX (Console) port	**flow-control** { **hardware** | **none** | **software** }
Restore the default flow control mode on AUX (Console) port	**undo flow-control**
Configure parity mode on the AUX (Console) port. By default, there is no parity bit on the AUX (Console) port	**parity** { **even** | **mark** | **none** | **odd** | **space** }
Restore the default parity mode	**undo parity**
Configure the stop bit of AUX (Console) port. By default, AUX (Console) port supports 1 stop bit	**stopbits** { **1** | **1.5** | **2** }
Restore the default stop bit of AUX (Console) port	**undo stopbits**
Configure the data bit of AUX (Console) port. By default, AUX (Console) port supports 8 data bits.	**databits** { **7** | **8** }
Restore the default data bit of AUX (Console) port	**undo databits**

Configuring the Terminal Attributes

The following commands can be used for configuring the terminal attributes, including enabling/disabling terminal service, disconnection upon timeout, lockable user interface, configuring terminal screen length and history command buffer size.

Perform the following configuration in user interface view. Perform the **lock** command in user view.

Enabling and Disabling Terminal Service After the terminal service is disabled on a user interface, you cannot log in to the Switch 8800 through the user interface. However, if a user logged in through the user interface before disabling the terminal service, the user can continue operation. After the user logs out, the user cannot log in again. In this case, the user can log in to the Switch through the user interface only when the terminal service is enabled again. Use the commands described in Table 4 to enable or disable terminal service.

Table 4 Enabling and Disabling Terminal Service

Operation	Command
Enable terminal service	**shell**
Disable terminal service	**undo shell**

By default, terminal service is enabled on all the user interfaces.

Note the following points:

- For the sake of security, the **undo shell** command can only be used on the user interfaces other than the AUX user interface.
- You cannot use this command on the user interface through which you log in.
- You must confirm your privilege before using the **undo shell** command in any legal user interface.

Configuring idle-timeout By default, idle-timeout is enabled and set to 10 minutes on all the user interfaces. The **idle-timeout** command is described in Table 5.

Table 5 Idle Timeout

Operation	Command
Configure idle-timeout	**idle-timeou**t *minutes* [*seconds*] (**idle-timeout** 0 means disabling idle-timeout.)
Restore the default idle-timeout	**undo idle-timeout**

Locking the User Interface The **lock** command locks the current user interface and prompts the user to enter a password. This makes it impossible for others to operate in the interface after the user leaves. The **lock** command is described in Table 6.

Table 6 Lock User Interface

Operation	Command
Lock user interface	**lock**

Setting the Screen Length If a command displays more than one screen of information, you can use the **screen length** command to determine how many lines are displayed on a screen so that information can be separated in different screens and you can view it more conveniently. The **screen-length** command is described in Table 7.

Table 7 Setting Screen Length

Operation	Command
Set the screen length	**screen-length** *screen-length* (**screen-length** 0 indicates to disable screen display separation function.)
Restore the default screen length	**undo screen-length**

By default, the terminal screen length is 24 lines.

Setting the History-Command Buffer Size

Table 8 describes the **history-command max-size** command.

By default, the size of the **history-command max-size** command buffer is 10.

Table 8 Set the History Command Buffer Size

Operation	Command
Set the history command buffer size	**history-command max-size** *value*

Table 8 Set the History Command Buffer Size

Operation	Command
Restore the default history command buffer size	**undo history-command max-size**

Managing Users

The management of users includes, the setting of the user logon authentication method, the level of command a user can use after logging on, the level of command a user can use after logging on from the specific user interface, and the command level.

Configuring the Authentication Method The **authentication-mode** command configures the user login authentication method that allows access to an unauthorized user. Table 9 describes the **authentication-mode** command.

Perform the following configuration in user interface view.

Table 9 Configure Authentication Method

Operation	Command
Configure the authentication method	**authentication-mode** { **password** | **scheme** }
Configure no authentication	**authentication-mode none**

By default, terminal authentication is not required for users who log in through the console port, whereas a password is required for authenticating modem and Telnet users when they log in.

To configure authentication for modem and Telnet users:

1 Configure local password authentication for the user interface.

When you set the password authentication mode, you must also configure a login password to log in successfully. Table 10 describes the **set authentication password** command.

Perform the following configuration in user interface view.

Table 10 Configure the Local Authentication Password

Operation	Command
Configure the local authentication password	**set authentication password** { **cipher** | **simple** } *password*
Remove the local authentication password	**undo set authentication password**

Configure for password authentication when a user logs in through a VTY 0 user interface and set the password to 3Com:

```
[SW8800]user-interface vty 0
[SW8800-ui-vty0]authentication-mode password
[SW8800-ui-vty0]set authentication password simple 3Com
```

2 Configure the local or remote authentication username and password.

Use the **authentication-mode scheme** command to perform local or remote authentication of username and password. The type of the authentication depends on your configuration. For detailed information, see "AAA and RADIUS Operation"

Perform username and password authentication when a user logs in through the VTY 0 user interface and set the username and password to zbr and 3Com respectively:

```
[SW8800-ui-vty0]authentication-mode scheme
[SW8800-ui-vty0]quit
[SW8800]local-user zbr
[SW8800-luser-zbr]service-type telnet
[SW8800-luser-zbr]password simple 3Com
```

3 Set the Switch 8800 to allow user access without authentication.

```
[SW8800-ui-vty0]authentication-mode none
```

By default, the password is required for authenticating the modem and Telnet users when they log in. If the password has not been set, when a user logs in, the following message displays, `Login password has not been set!`

If the ***authentication-mode none*** *command is used, the modem and Telnet users are not required to enter a password.*

Set the Command Level after Login The following command is used for setting the command level used after a user logs in.

Perform the following configuration in local-user view.

Table 11 Set Command Level Used After a User Logs In

Operation	Command
Set the command level used after a user logging in	**service-type** { **level** *level* | **telnet** [**level** *level*]] | **telnet** [**level** *level*] }
Restore the default command level used after a user logging in	**undo service-type** { **level** | **telnet** [**level**]] | **telnet** [**level**] }

By default, a Telnet user can access the commands at Level 1 after logon.

Setting the Command Level Used after a User Logs in from a User Interface

Use the **user privilege level** command to set the command level, after a user logs in from a specific user interface, so that a user is able to execute the commands at that command level. Table 12 describes the **user privilege level** command.

Perform the following configuration in user interface view.

Table 12 Set Command Level After User Login

Operation	Command
Set command level used after a user logging in from a user interface	**user privilege level** *level*
Restore the default command level used after a user logging in from a user interface	**undo user privilege** *level*

By default, a user can access the commands at Level 3 after logging in through the AUX user interface, and the commands at Level 0 after logging in through the VTY user interface.

When a user logs in to the switch, the command level that the user can access depends on two points. One is the command level that the user can access, the other is the set command level of the user interface. If the two levels are different, the former is taken. For example, the command level of VTY 0 user interface is 1, however, user Tom has the right to access commands of level 3; if Tom logs in from VTY 0 user interface, he can access commands of level 3 and lower.

Setting Command Priority The **command-privilege level** command sets the priority of a specified command in a certain view. The command levels include visit, monitoring, configuration, and management, which are identified with command level 0 through 3, respectively. An administrator assigns authority according to user requirements. See Table 13.

Perform the following configuration in system view.

Table 13 Set Command Priority

Operation	Command
Set the command priority in a specified view.	**command-privilege level** *level* **view** *view command*
Restore the default command level in a specified view.	**undo command-privilege view** *view command*

Configuring the Attributes of a Modem

You can use the commands described in Table 14 to configure the attributes of a modem when logging in to the Switch through the modem.

Perform the following configuration in user interface view.

Table 14 Configure Modem

Operation	Command
Set the interval since the system receives the RING until CD_UP	**modem timer answer** *seconds*
Restore the default interval since the system receives the RING until CD_UP	**undo modem timer answer**
Configure auto answer	**modem auto-answer**
Configure manual answer	**undo modem auto-answer**
Configure to allow call-in	**modem call-in**
Configure to bar call-in	**undo modem call-in**
Configure to permit call-in and call-out.	**modem both**
Configure to disable call-in and call-out	**undo modem both**

Configuring Redirection

The send Command can be used for sending messages between user interfaces. See Table 15.

Perform the following configuration in user view.

Table 15 Configure to Send Messages Between User Interfaces

Operation	Command
Configure to send messages between different user interfaces.	**send** { **all** | *number* | *type number* }

The auto-execute Command is used to run a command automatically after you log in. The command is automatically executed when you log in again. See Table 16.

This command is usually used to execute the **telnet** command automatically on a terminal, which connects the user to a designated device.

Perform the following configuration in user interface view.

Table 16 Configure Automatic Command Execution

Operation	Command
Configure to automatically run the command	**auto-execute command** *text*
Configure not to automatically run the command	**undo auto-execute command**

*After applying the **auto-execute** command, the user interface can no longer be used to carry out the routine configurations for the local system.*

*Make sure that you will be able to log in to the system in some other way and cancel the configuration before you use the **auto-execute** command and save the configuration.*

Telnet 10.110.100.1 after the user logs in through VTY0 automatically.:

```
[SW8800-ui-vty0]auto-execute command telnet 10.110.100.1
```

When a user logs on by VTY 0, the system will run **telnet 10.110.100.1** automatically.

Displaying and Debugging User Interface

After creating the previous configuration, execute the **display** command in all views to display the user interface configuration, and to verify the effect of the configuration. Execute the **free** command in user view to clear a specified user interface.

Table 17 Display and Debug User Interface

Operation	Command
Clear a specified user interface	**free user-interface** [*type*] *number*
Display the user application information of the user interface	**display users** [**all**]
Display the physical attributes and some configurations of the user interface	**display user-interface** [*type number*] [*number*] [**summary**]

See Table 17.

Command Line Interface

The Switch 8800 provides a series of configuration commands and command line interfaces for configuring and managing the Switch 8800. The command line interface has the following features.

- Local configuration through the console and AUX ports.
- Local or remote configuration through Telnet.
- Remote configuration through a dial-up Modem through the AUX port to log in to the Switch 8800.
- Hierarchy command protection to prevent unauthorized users from accessing the switch.
- Access to online Help by entering **?**.
- Network test commands, such as Tracert and Ping, for rapid troubleshooting of the network.
- Detailed debugging information to help with network troubleshooting.
- Ability to log in and manage other Switch 8800s directly, using the **telnet** command.
- FTP service for the users to upload and download files.
- Ability to view previously executed commands.
- The command line interpreter that searches for a target not fully matching the keywords. You can enter the whole keyword or part of it, as long as it is unique and not ambiguous.

Configuring a Command Line Interface is described in the following sections:

- Command Line View
- Features and Functions of the Command Line

Command Line View

The Switch 8800 provides hierarchy protection for the command lines to prevent unauthorized users from accessing the switch illegally.

There are four levels of commands:

- Visit level — involves commands for network diagnosis tools (such as **ping** and **tracert**), command of the switch between different language environments of user interface (language-mode) and the **telnet** command. Saving the configuration file is not allowed on this level of commands.
- Monitoring level — includes the **display** command and the **debugging** command for system maintenance, service fault diagnosis, and so on. Saving the configuration file is not allowed on this level of commands.
- Configuration level — provides service configuration commands, such as the **routing** command and commands on each network layer that are used to provide direct network service to the user.
- Management level — influences the basic operation of the system and the system support module which plays a support role for service. Commands at this level involve file system commands, FTP commands, TFTP commands, XModem downloading commands, user management commands, and level setting commands.

Login users are also classified into four levels that correspond to the four command levels. After users of different levels log in, they can only use commands at their own, or lower, levels.

To prevent unauthorized users from illegal intrusion, users are identified when switching from a lower level to a higher level with the **super** [*level*] command. User ID authentication is performed when users at a lower level switch to users at a higher level. Only when correct password is entered three times, can the user switch to the higher level. Otherwise, the original user level remains unchanged.

Command views are implemented according to requirements that are related to one another. For example, after logging in to the Switch 8800, you enter user view, in which you can only use some basic functions, such as displaying the operating state and statistics information. In user view, key in **system-view** to enter system view, in which you can key in different configuration commands and enter the corresponding views.

The command line provides the following views:

- User view
- System view
- Ethernet Port view
- VLAN view
- VLAN interface view
- Local-user view
- User interface view
- FTP client view
- PIM view
- RIP view
- OSPF view
- OSPF area view
- Route policy view
- Basic ACL view
- Advanced ACL view
- Layer-2 ACL view
- RADIUS server group view
- ISP domain view
- BGP view
- ISIS view

The relation diagram of the views is shown in Figure 13.

Figure 13 Relation Diagram of the Views

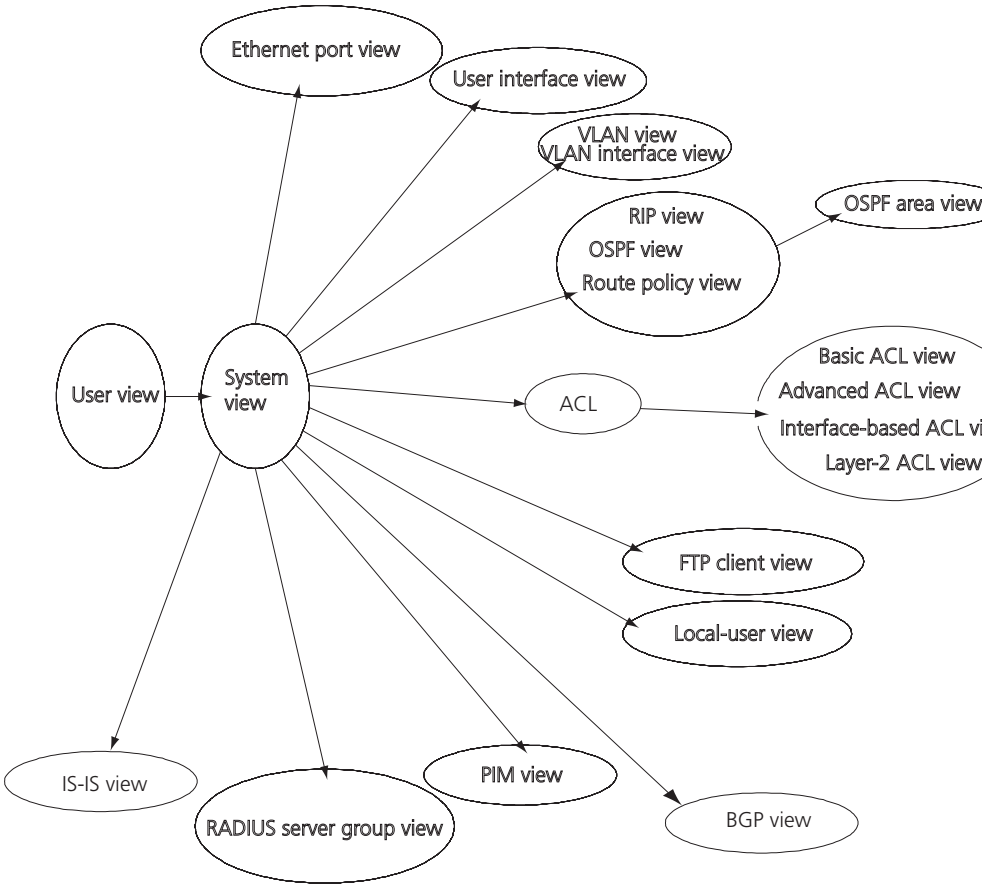


Table 18 describes the function features of different views.

For all views, use the **quit** command to return to system view and use the **return** command to return to user view.

Table 18 Function Feature of Command View

Command view	Function	Prompt	Command to enter
User view	Show basic information about operation and statistics	`<SW8800>`	Enter right after connecting the switch
System view	Configure system parameters	`[SW8800]`	Key in **system-view** in user view
Ethernet Port view	Configure Ethernet port parameters	`[SW8800-GigabitEthernet1/1/1]`	100M Ethernet port view
		`[SW8800-GigabitEthernet1/1/1]`	Gigabit Ethernet port view
VLAN view	Configure VLAN parameters	`[SW8800-Vlan1]`	Enter **vlan 1** in System view
VLAN interface view	Configure IP interface parameters for a VLAN or a VLAN aggregation	`[SW8800-Vlan-interface1]`	Enter **interface vlan-interface** 1 in System view

Table 18 Function Feature of Command View (continued)

Command view	Function	Prompt	Command to enter
Local-user view	Configure local user parameters	`[SW8800-user-user1]`	Enter **local-user user1** in System view
User interface view	Configure user interface parameters	`[SW8800-ui0]`	Enter **user-interface** 0 in System view
FTP Client view	Configure FTP Client parameters	`[ftp]`	Enter **ftp** in user view
PIM view	Configure PIM parameters	`[SW8800-PIM]`	Enter **pim** in System view
RIP view	Configure RIP parameters	`[SW8800-rip]`	Enter **rip** in System view
OSPF view	Configure OSPF parameters	`[SW8800-ospf]`	Enter **ospf** in System view
OSPF area view	Configure OSPF area parameters	`[SW8800-ospf-0.0.0.1]`	Enter **area** 1 in OSPF view
Route policy view	Configure route policy parameters	`[SW8800-route-policy]`	Enter **route-policy** policy1 **permit node** 10 in System view
Basic ACL view	Define the rule of basic ACL	`[SW8800-acl-basic-2000]`	Enter **acl number** 2000 in System view
Advanced ACL view	Define the rule of advanced ACL	`[SW8800-acl-adv-3000]`	Enter **acl number** 3000 in System view
Layer-2 ACL view	Define the rule of layer-2 ACL	`[SW8800-acl-link-4000]`	Enter **acl number** 4000 in System view
RADIUS server group view	Configure radius parameters	`[SW8800-radius-1]`	Enter **radius scheme** 1 in System view
ISP domain view	Configure ISP domain parameters	`[SW8800-isp-163.net]`	Enter **domain** isp-163.net in System view

Features and Functions of the Command Line

Tasks for configuring the features and functions of the command line are described as follows:

- Online Help
- Common Command Line Error Messages
- History Command
- Editing Features of the Command Line
- Displaying Features of the Command Line

Online Help

The command line interface provides full and partial online Help modes.

You can get the help information through these online help commands, which are described as follows.

- Enter **?** in any view to get all the commands in it and corresponding descriptions.

```
<SW8800>?
User view commands:
  language-mode Specify the language environment
  ping  Ping function
```

```
  quit  Exit from current command view
  super Enter the command workspace with specified user priority
level
  telnetEstablish one TELNET connection
  tracertTrace route function
```

- Enter a command with a **?**, separated by a space. If this position is for keywords, then all the keywords and the corresponding brief descriptions will be listed.

```
<SW8800>ping ?
-a    Select source IP address
-c    Specify the number of echo requests to send
-d    Specify the SO_DEBUG option on the socket being used
-h    Specify TTL value for echo requests to be sent
-I    Select the interface sending packets
-n Numeric output only. No attempt will be made to lookup host
addresses for symbolic names
-p No more than 8 "pad" hexadecimal characters to fill out the sent
packet. For example, -p f2 will fill the sent packet with f and 2
repeatedly
-q Quiet output. Nothing is displayed except the summary lines at
startup time and when finished
-r Record route. Includes the RECORD_ROUTE option in the ECHO_REQUEST
packet and displays the route
-s    Specifies the number of data bytes to be sent
-t    Timeout in milliseconds to wait for each reply
-v Verbose output. ICMP packets other than ECHO_RESPONSE that are
received are listed
STRING<1-20> IP address or hostname of a remote system
Ip    IP Protocol
```

- Enter a command with a **?**, separated by a space. If this position is for parameters, all the parameters and their brief descriptions will be listed.

```
[SW8800]garp timer leaveall ?
  INTEGER<65-32765>  Value of timer in centiseconds
                     (LeaveAllTime > (LeaveTime [On all ports]))
                     Time must be multiple of 5 centiseconds
[SW8800]garp timer leaveall 300 ?
  <cr>
```

  <cr> indicates no parameter in this position. The next command line repeats the command, you can press *Ente*r to execute it directly.

- Enter a character string with a **?**, and list all the commands beginning with this character string.

```
<SW8800>p?
ping
```

- Input a command with a character string and **?**, and list all the key words beginning with this character string in the command.

```
<SW8800>display ver?
  version
```

Common Command Line Error Messages

All the commands that are entered by users can be correctly executed if they have passed the grammar check. Otherwise, error messages are reported to users. Common error messages are listed in Table 19.

Table 19 Common Command Line Error Messages

Error messages	Causes
Unrecognized command	Cannot find the command.
Cannot find the keyword.	Wrong parameter type.
The value of the parameter exceeds the range.	Incomplete command
The command is incomplete.	Too many parameters
You entered too many parameters.	Ambiguous command
The parameters you entered are not specific.	

History Command

The command line interface provides a function similar to DosKey. The commands entered by users can be automatically saved by the command line interface and you can invoke and execute them at any time. By default, the history command buffer can store 10 history commands for each user. The operations are shown in Table 20.

Table 20 Retrieve History Command

Operation	Key	Result
Display history command	**display history-command**	Displays **history** commands by the user who is entering them.
Retrieve the previous history command	Up cursor key <> or <Ctrl+P>	Retrieves the previous history command, if there is any.
Retrieve the next history command	Down cursor key <> or <Ctrl+N>	Retrieves the next history command, if there is any.

Editing Features of the Command Line

The command line interface provides a basic command editing function and supports editing multiple lines. A command cannot be longer than 256 characters. See Table 21.

Table 21 Editing Functions

Key	Function
Common keys	Inserts at the cursor position and the cursor moves to the right, if the edition buffer still has free space.
Backspace	Deletes the character preceding the cursor and the cursor moves backward.
Left cursor key < or *Ctrl+B*	Moves the cursor a character backward
Right cursor key > or *Ctrl+F*	Moves the cursor a character forward
Up cursor key ^ or *Ctrl+P* Down cursor key v or *Ctrl+N*	Retrieves the history command.

Table 21 Editing Functions

Key	Function
Tab	Press *Tab* after typing the incomplete key word and the system will execute the partial help: If the key word matching the typed one is unique, the system will replace the typed one with the complete key word and display it in a new line. If there is not a matched key word or the matched key word is not unique, the system will do no modification but displays the originally typed word in a new line.

Displaying Features of the Command Line

If information to be displayed exceeds one screen, the pause function allows users three choices, as described in Table 22.

Table 22 Display Functions

Key or Command	Function
Press *Ctrl*+*C* when the display pauses	Stop displaying and executing command.
Enter a space when the display pauses	Continue to display the next screen of information.
Press *Enter* when the display pauses	Continue to display the next line of information.

2 PORT CONFIGURATION

This chapter covers the following topics:

- Ethernet Port Overview
- Configuring Link Aggregation

Ethernet Port Overview

The following features are found in the Ethernet ports of the Switch 8800:

- 10GBASE-X-XENPAK 10-Gigabit Ethernet ports work in 10-gigabit full duplex mode.
- 10GBASE-X-XFP operates in 10 Gbps full duplex mode, which needs no configuring.
- 1000BASE-X-SFP Gigabit Ethernet ports work in gigabit full duplex mode.
- 10/100/1000BASE-T Gigabit Ethernet ports support MDI/MDI-X auto-sensing, and the modes are 1000 Mbps full duplex, 100 Mbps half/full duplex, and 10 Mbps half/full duplex. These modules also support auto-negotiation

Configuring an Ethernet port is described in the following sections:

- Configuring Ethernet Ports
- Example: Configuring the Default VLAN ID of the Trunk Port
- Troubleshooting VLAN Port Configuration

Configuring Ethernet Ports

Tasks for configuring Ethernet ports are described in the following sections:

- Entering Ethernet Port View
- Enabling and Disabling Ethernet Ports
- Setting the Description Character String for an Ethernet Port
- Setting the Duplex Attribute of the Ethernet Port
- Setting the Speed of the Ethernet Port
- Setting the Cable Type for an Ethernet Port
- Setting Flow Control for an Ethernet Port
- Permitting/Forbidding Jumbo Frames on the Ethernet port
- Setting the Maximum MAC Addresses an Ethernet Port Can Learn
- Setting the Link Type for an Ethernet Port
- Adding an Ethernet Port to a VLAN
- Setting the Default VLAN ID for an Ethernet Port
- Copying a Port Configuration to Other Ports

- Displaying and Debugging Ethernet Ports

Entering Ethernet Port View

Before configuring the Ethernet port, enter Ethernet port view.

Perform the following configuration in system view.

Table 1 Enter Ethernet Port View

Operation	Command
Enter Ethernet port view	**interface** { *Gigabit* | *Ethernet* } *slot/subslot/port*

The subslot on the Fabric is always set to 1.

Enabling and Disabling Ethernet Ports

The following command can be used for disabling or enabling the port. After configuring the related parameters and protocol of the port, you can use the following command to enable the port.

Perform the following configuration in Ethernet port view.

Table 2 Enable/Disable an Ethernet Port

Operation	Command
Disable an Ethernet port	**shutdown**
Enable an Ethernet port	**undo shutdown**

By default, the port is enabled.

Setting the Description Character String for an Ethernet Port

You can use the following command to identify the Ethernet ports.

Perform the following configuration in Ethernet port view.

Table 3 Set Description Character String for Ethernet Port

Operation	Command
Set description character string for Ethernet port.	**description** *text*
Delete the description character string of Ethernet.	**undo description**

By default, the port description is a null character string.

Setting the Duplex Attribute of the Ethernet Port

Set the port to full duplex to send and receive data packets at the same time. Set the port to half-duplex to either send or receive only. If the port has been set to auto-negotiation mode, the local and peer ports will automatically negotiate the duplex mode.

Perform the following configuration in Ethernet port view.

Table 4 Set the Duplex Attribute for an Ethernet Port

Operation	Command
Set the duplex attribute for an Ethernet port.	**duplex** {**auto** | **full** | **half**}
Restore the default duplex attribute of Ethernet port.	**undo duplex**

The Gigabit Ethernet Base-T ports can operate in full duplex, half duplex, or auto-negotiation mode. When the ports operate at 1000 Mbps, the duplex mode can be set to full (full duplex) or auto (auto-negotiation).

By default, the port is in **auto** (auto-negotiation) mode.

Setting the Speed of the Ethernet Port

You can use the following command to set the speed on the Ethernet port. If the speed is set to auto (auto-negotiation) mode, the local and peer ports will automatically negotiate the port speed.

Perform the following configuration in Ethernet port view.

Table 5 Set Speed on Ethernet Port

Operation	Command
Set Ethernet port speed	**speed** {**10** | **100** | **1000** | **auto**}
Restore the default speed on Ethernet port	**undo speed**

The Gigabit Ethernet BASE-T port can operate at 10 Mbps, 100 Mbps, or 1000 Mbps. However in half duplex mode, the port cannot operate at 1000 Mbps. The Gigabit optical Ethernet port supports1000 Mbps; the 10 Gigabit optical Ethernet port supports 10000 Mbps, which does not need to be configured.

Setting the Cable Type for an Ethernet Port

The Ethernet port supports the straight-through (MDI) and cross-over (MDIX) network cables. The Switch 8800 only supports auto (auto-sensing). If you set some other type, you will see an error message. By default, the cable type is auto (auto-recognized). The system will automatically recognize the type of cable connecting to the port.

Perform the following configuration in Ethernet port view. The settings only take effect on 10/100/1000 Mbps electrical ports.

Table 6 Set the Type of the Cable Connected to the Ethernet Port

Operation	Command
Set the type of the cable connected to the Ethernet port.	**mdi { auto }**
Restore the default type of the cable connected to the Ethernet port.	**undo mdi**

Setting Flow Control for an Ethernet Port

If flow control is enabled on both the local and the peer switch and congestion occurs in the local switch, the local switch can instruct its peer to temporarily stop sending packets. Once the peer switch receives this message, it stops sending

packets and packet loss is reduced. The flow control function of the Ethernet port can be enabled or disabled using the following commands.

Perform the following configuration in Ethernet port view.

Table 7 Set Flow Control for Ethernet Port

Operation	Command
Enable Ethernet port flow control	**flow-control**
Disable Ethernet port flow control	**undo flow-control**

By default, Ethernet port flow control is disabled.

Permitting/Forbidding Jumbo Frames on the Ethernet port

Using the **jumbo frame enable** command, you can allow jumbo frames (1523 to to 9216 bytes) to pass through the specified Ethernet port. Note that packets of 1518 to 1522 bytes, including the IEEE 802.1Q tagging are always allowed to pass through Ethernet ports.

Jumbo frames are only allowed for Ethernet Type II frames. Most network equipment, including NICs, switches, and routers are not capable of supporting jumbo frames and will always discard these packets.

Perform the following configuration in Ethernet port view.

Table 8 Permitting/Forbidding Jumbo Frames to Pass Through the Ethernet Port

Operation	Command
Permit jumbo frame to pass through the Ethernet port.	**jumboframe enable [** *jumboframe_value* **]**
Forbid jumbo frame to pass through the Ethernet port.	**undo jumboframe enable**

By default, jumbo frames are disabled.

Setting the Maximum MAC Addresses an Ethernet Port Can Learn

Use the following command to set a limit on the number of MAC addresses that an Ethernet port will learn.

Perform the following configuration in Ethernet port view.

Table 9 Set a Limit on the Number of MAC Addresses Learned by an Ethernet Port

Operation	Command
Set a limit on the number of MAC addresses learned by an Ethernet port	**mac-address max-mac-count** *count*
Restore the default limit on MAC addresses learned by the Ethernet port	**undo mac-address max-mac-count**

If the count parameter is set to 0, the port is not permitted to learn MAC address. By default, there is no limit to the amount of the MAC addresses that an Ethernet port can learn. However the number of MAC addresses a port can learn is still restricted by the size of the MAC address table.

Setting the Ethernet Port Broadcast Suppression Ratio

You can use the following commands to restrict the broadcast traffic. Once the broadcast traffic exceeds the value set by the user, the system maintains an appropriate broadcast packet ratio by discarding the overflow traffic. This is done to suppress broadcast storm, avoid congestion, and ensure good traffic flow.

The parameter indicates the maximum wire speed ratio of the broadcast traffic allowed on the port. The smaller the ratio, the smaller the amount of broadcast traffic allowed. If the ratio is 100%, broadcast storm suppression is not performed on the port.

Perform the following configuration in Ethernet port view.

Table 10 Setting the Ethernet Port Broadcast Suppression Ratio

Operation	Command
Set the Ethernet port broadcast suppression ratio	**broadcast-suppression pct**
Restore the default Ethernet port broadcast suppression ratio	**undo broadcast-suppression**

By default, 100% broadcast traffic is allowed to pass through and no broadcast suppression is performed.

Setting the Link Type for an Ethernet Port

An Ethernet port can operate in three different link modes, access, hybrid, and trunk. The management access port carries one VLAN only and is used for connecting to the user's computer.

A trunk port can belong to more than one VLAN and can transmit packets on multiple VLANs. A hybrid port can also belong to more than one VLAN and transmit packets on multiple VLANs.

However, the hybrid port allows packets from multiple VLANs to be sent without tags but the trunk port only allows packets from the default VLAN to be sent without tags.

Perform the following configuration in Ethernet port view.

Table 11 Set the Link Type for an Ethernet Port

Operation	Command
Configure the port as an access port	**port link-type access**
Configure the port as a hybrid port	**port link-type hybrid**
Configure the port as a trunk port	**port link-type trunk**
Restore the default link type, that is, the access port.	**undo port link-type**

A port on a switch can be configured as an access port, a hybrid port, or a trunk port. However, to reconfigure between hybrid and trunk link types, you must first restore the default, or access link type.

The default port link type is the access link type.

Adding an Ethernet Port to a VLAN

The following commands are used for adding an Ethernet port to a specified VLAN. Access ports can be added to only one VLAN, while hybrid and trunk ports can be added to multiple VLANs.

Perform the following configuration in Ethernet port view.

Table 12 Adding an Ethernet Port to Specified VLANs

Operation	Command
Add the current access port to a specified VLAN	**port access vlan** *vlan_id*
Add the current hybrid port to specified VLANs	**port hybrid vlan** *vlan_id_list* {**tagged** | **untagged**}
Add the current trunk port to specified VLANs	**port trunk permit vlan** {*vlan_id_list* | **all**}
Remove the current access port from to a specified VLAN.	**undo port access vlan**
Remove the current hybrid port from to specified VLANs.	**undo port hybrid vlan** *vlan_id_list*
Remove the current trunk port from specified VLANs.	**undo port trunk permit vlan** {*vlan_id_list* | **all**}

The access port will be added to an existing VLAN other than VLAN 1. The VLAN to which a Hybrid port is added must exist. The VLAN to which a Trunk port is added cannot be VLAN 1.

After adding the Ethernet port to the specified VLANs, the local port can forward packets from these VLANs. The hybrid and trunk ports can be added to multiple VLANs, thereby, implementing the VLAN intercommunication between peers. For the hybrid port, you can tag VLAN packets to process packets in different ways, depending on the target device.

Setting the Default VLAN ID for an Ethernet Port

An access port can only be included in one VLAN so its default VLAN is the VLAN to which it belongs.

The hybrid port and the trunk port can be included in several VLANs but a default VLAN ID must be configured. If the default VLAN ID has been configured, the packets without a VLAN tag are forwarded to the port that belongs to the default VLAN. When the system sends packets with a VLAN tag, if the VLAN ID of the packet is identical to the default VLAN ID of the port, the system will remove the VLAN tag before sending this packet.

Perform the following configuration in Ethernet port view.

Table 13 Set the Default VLAN ID for the Ethernet Port

Operation	Command
Set the default VLAN ID for the hybrid port.	**port hybrid pvid vlan** *vlan_id*
Set the default VLAN ID for the trunk port	**port trunk pvid vlan** *vlan_id*
Restore the default VLAN ID of the hybrid port to the default value	**undo port hybrid pvid**
Restore the default VLAN ID of the trunk port to the default value	**undo port trunk pvid**

To guarantee proper packet transmission, the default VLAN ID of local hybrid port or Trunk port should be identical to that of the hybrid port or Trunk port on the peer switch. The VLAN of hybrid port and trunk port is VLAN 1 by default. The access port is the VLAN to which it belongs.

Copying a Port Configuration to Other Ports

To keep the configuration of other ports consistent with a specified port, you can copy the configuration of that specified port to other ports. Port configuration involves the following settings:

- STP setting — includes STP enabling/disabling, link attribute (point-to-point or not), STP priority, path cost, max transmission speed, loop protection, root protection, edge port or not.
- QoS setting — includes traffic limiting, priority marking, default 802.1p priority, bandwidth assurance, congestion avoidance, traffic redirection, traffic statistics.
- VLAN setting — includes permitted VLAN types, default VLAN ID.
- Port setting — includes port link type, port speed, duplex mode.

Perform the following configuration in system view.

Table 14 Copying a Port Configuration to Other Ports

Operation	Command
Copy port configuration to other ports	**copy configuration source** { *interface-type interface-number* | *interface-name* | **aggregation-group** *agg-id* } **destination** { *interface_list* [**aggregation-group** *agg-id*] | **aggregation-group** *agg-id* }

Note that if the copy source is an aggregation group, use the port with the lowest ID as the source. If the copy destination is an aggregation group, make the configurations of all group member ports identical with that of the source.

Displaying and Debugging Ethernet Ports

After configuration, execute the **display** command in all views to display the current configuration of Ethernet port parameters, and to verify the configuration.

Use the **reset** command in user view to clear the statistics from the port.

Use the **loopback** command in Ethernet port view to configure the Ethernet port in internal loop mode. Use the **undo loopback** command in Ethernet port view to cancel the loop setting.

Table 15 Display and Debug Ethernet Port

Operation	Command
Display all the information of the port	**display interface** {*interface_type* | *interface_type interface_num* | *interface_name*}
Display hybrid port or trunk port	**display port {hybrid | trunk}**
Clear the statistics information of the port	**reset counters interface** [*interface_type* | *interface_type interface_num* | *interface_name*]

Example: Configuring the Default VLAN ID of the Trunk Port

In this example, Switch A is connected to the peer, Switch B, through the trunk port GigabitEthernet2/1/1. Configure the trunk port with a default VLAN ID, so that the port can forward packets to the member ports belonging to the default VLAN when it receives them without a VLAN tag. When it sends the packets with VLAN tag and the packet VLAN ID is the default VLAN ID, the trunk port removes the packet VLAN tag and forward the packet.

Figure 1 Configure the Default VLAN for a Trunk Port

The following configurations are used for Switch A, configure Switch B in a similar way:

1. Enter the Ethernet port view of Ethernet2/1/1.

```
[SW8800]interface gigabitethernet2/1/1
```

2. Set the GigabitEthernet2/1/1 to be a trunk port which allows VLAN 2, 6 through 50, and 100 to pass through.

```
[SW8800-GigabitEthernet2/1/1]port link-type trunk
[SW8800-GigabitEthernet2/1/1]port trunk permit vlan 2 6 to 50 100
```

3. Create the VLAN 100.

```
[SW8800]vlan 100
```

4. Configure the default VLAN ID of GigabitEthernet2/1/1 as 100.

```
[SW8800-GigabitEthernet2/1/1]port trunk pvid vlan 100
```

Troubleshooting VLAN Port Configuration

If the default VLAN ID configuration fails, take the following steps:

1. Execute the **display interface** or **display port** command to check if the port is a trunk port or a hybrid port. If it is neither, configure it as a trunk port or a hybrid port.
2. Then configure the default VLAN ID.

Configuring Link Aggregation

Link aggregation means aggregating several ports together to implement the outgoing/incoming payload balance among the member ports and to enhance connection reliability.

For the member ports in an aggregation group, their basic configurations must be the same. That is, if one is a trunk port, others must be trunk ports also. If a port turns into an access port, then others must change to access ports.

Basic configuration includes:

- STP setting
  - STP enabling and disabling
  - Link attribute (point-to-point or not)

- STP priority
- Path cost
- Maximum transmission speed
- Loop protection
- Root protection
- Type of port (edge)

- QoS setting
  - Traffic limiting
  - Priority marking
  - Default 802.1p priority
  - Bandwidth assurance
  - Congestion avoidance
  - Traffic redirection
  - Traffic statistics.
- VLAN setting
  - Permitted VLAN types
  - Default VLAN ID
- Port setting
  - Port link type

The Switch 8800 supports a maximum of 31 link aggregation groups, with a maximum of eight ports in each group.

Load Sharing

Link aggregation may be load balancing aggregation or non-load balancing aggregation. In general, the system only provides limited load balancing aggregation resources, so the system needs to rationally allocate these resources among aggregation groups. The system will always allocate hardware aggregation resources to the aggregation groups with higher priority levels. When the load sharing aggregation resources are used up for existing aggregation groups, newly-created aggregation groups will be non-load sharing groups. The priority levels (in descending order) for allocating load sharing aggregation resources are aggregation groups that:

- Include special ports which require hardware aggregation resources
- Are likely to reach the maximum rate after the resources are allocated to them
- Have the minimum master port numbers if they reach an equal rate with other groups after the resources are allocated to them

When aggregation groups of higher priority levels appear, the aggregation groups of lower priority levels release their hardware resources. For single-port aggregation groups, if they can transmit packets normally without occupying hardware resources, they cannot occupy the resources.

Port State

In an aggregation group, ports may be in *selected* or *standby* state and only the selected ports can transmit user service packets. The selected port with the minimum port number serves as the master port, while others serve as sub-ports.

In an aggregation group, the system sets the ports to selected or standby state based on these rules:

- The system sets the port with the highest priority to selected state, and sets others to standby state based on the descending order of priority levels, as follows:
  - full duplex/high speed
  - full duplex/low-speed
  - half duplex/high speed
  - half duplex/low speed
- The system sets to standby state the ports which cannot aggregate with the selected port with the lowest port number, due to hardware limits.
- The system sets to standby state the ports with basic configurations different from that of the selected port with the lowest port number.

Only a defined number of ports can be supported in an aggregation group, so if the selected ports in an aggregation group exceed the port quantity threshold for that group, the system sets some ports with smaller port numbers (in ascending order) as selected ports and others as standby ports. The selected ports can transmit user service packets, but standby ports cannot.

A load sharing aggregation group may contain several selected ports, but a non-load sharing aggregation group can only have one selected port, while others are standby ports.

Configuring Link Aggregation

The Switch 8800 only supports link aggregation for ports on the same I/O module. A maximum number of 8 ports can be selected in a link aggregation. For modules that have fewer than 8 ports, such as the 2-port 10GBASE-X module, only two ports can be selected members of a link aggregation.

Link aggregation configuration includes tasks described in the following sections:

- Creating or Deleting an Aggregation Group
- Adding or Deleting Ethernet Ports to or from an Aggregation Group
- Setting or Deleting an Aggregation Group Descriptor
- Displaying and Debugging Link Aggregation

Creating or Deleting an Aggregation Group

You can use the following command to create a manual aggregation group. You can also delete an existing aggregation group. When you delete a manual aggregation group, all its member ports are removed from the aggregation.

Perform the following configuration in system view.

Table 16 Create or Delete an Aggregation Group

Operation	Command
Create an aggregation group	**link-aggregation group** *agg-id* **mode** { **manual** }
Delete an aggregation group	**undo link-aggregation group** *agg-id*

Adding or Deleting Ethernet Ports to or from an Aggregation Group

You can use the following commnad to add or delete ports into/from a manual aggregation group.

Perform the following configuration in corresponding view.

Table 17 Adding or Deleting an Ethernet Port to or from an Aggregation Group

Operation	Command
Add an Ethernet port into the aggregation group (Ethernet port view)	**port link-aggregation group** *agg-id*
Delete an Ethernet port from the aggregation port (Ethernet port view)	**undo port link-aggregation group**
Aggregate Ethernet ports (System view)	**link-aggregation** *interface_name1* **to** *interface_name2* [**both**]

Note that you must delete the aggregation group, instead of the port, if the manual aggregation group contains only one port.

Setting or Deleting an Aggregation Group Descriptor

Perform the following configuration in system view.

Table 18 Setting or Deleting an Aggregation Group Descriptor

Operation	Command
Set aggregation group descriptor	**link-aggregation group** *agg-id* **description** *alname*
Delete aggregation group descriptor	**undo link-aggregation group** *agg-id* **description**

By default, an aggregation group has no descriptor.

Displaying and Debugging Link Aggregation

After you have completed your configuration, execute the **display** command in any view to display the link aggregation configuration, and to verify the effect of the configuration.

Table 19 Display and Debug Link Aggregation

Operation	Command
Display summary information of all aggregation groups	**display link-aggregation summary**
Display detailed information of a specific aggregation group	**display link-aggregation verbose** *agg-id*

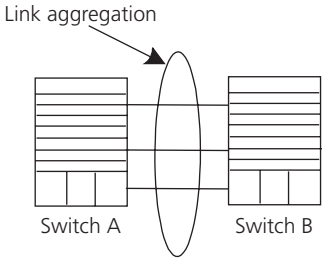
Table 19 Display and Debug Link Aggregation (continued)

Operation	Command
Display detailed link aggregation information at the port	**display link-aggregation interface** { *interface-type interface-number* | *interface-name* } [**to** { *interface-type interface-num* | *interface-name* }]
Disable/enable debugging link aggregation errors	[**undo**] **debugging link-aggregation error**
Disable/enable debugging link aggregation events	[**undo**] **debugging link-aggregation event**

Example: Link Aggregation Configuration

Switch A connects switch B with three aggregation ports, numbered as GigabitEthernet2/1/1 to GigabitEthernet2/1/3, so that the incoming and outgoing loads can be balanced among the member ports.

Figure 2 Networking For Link Aggregation



The following code example lists only the configuration for switch A. The configuration for switch B is similar.

1 Configure aggregation group 1.

```
[SW8800]link-aggregation group 1 mode manual
```

Add Ethernet ports GigabitEthernet2/1/1 to GigabitEthernet2/1/3 into aggregation group 1.

```
[SW8800]interface gigabitethernet2/1/1
[SW8800-GigabitEthernet2/1/1]port link-aggregation group 1
[SW8800-GigabitEthernet2/1/1]interface ethernet2/1/2
[SW8800-GigabitEthernet2/1/2]port link-aggregation group 1
[SW8800-GigabitEthernet2/1/2]interface ethernet2/1/3
[SW8800-GigabitEthernet2/1/3]port link-aggregation group 1
```

3 VLAN CONFIGURATION

This chapter covers the following topics:

- VLAN Overview
- Configuring VLANs
- Configuring GARP/GVRP

VLAN Overview

A virtual local area network (VLAN) creates logical groups of LAN devices into segments to implement virtual workgroups.

Using VLAN technology, you can logically divide the physical LAN into different broadcast domains. Every VLAN contains a group of workstations with the same resource requirements. However, the workstations of a VLAN do not have to belong to the same physical LAN segment.

Within a VLAN, broadcast and unicast traffic is not forwarded to other VLANs. Therefore, VLAN configurations are very helpful in controlling network traffic, simplifying network management, and improving security.

The Switch 8800 supports port-based VLANs, which define VLAN members according to switch ports. This is the simplest and most efficient way to create VLANs.

Configuring VLANs

The following sections describe how to configure VLANs:

- Common VLAN Configuration Tasks

Common VLAN Configuration Tasks

The following sections discuss the common tasks for configuring a VLAN:

- Creating or Deleting a VLAN
- Adding Ethernet Ports to a VLAN
- Setting or Deleting the VLAN Description Character String
- Specifying or Removing VLAN Interfaces
- Shutting Down or Enabling a VLAN Interface
- Displaying and Debugging a VLAN

Creating or Deleting a VLAN

Use the following command to create or delete a VLAN.

Perform the following configurations in system view.

Table 1 Creating or Deleting a VLAN

Operation	Command
Create and enter a VLAN view	**vlan** *vlan_id*
Delete the specified VLAN	**undo vlan** { *vlan_id* [**to** *vlan_id*] / **all** }

The command creates the VLAN then enters the VLAN view. If the VLAN already exists, the command enters the VLAN view directly.

Note that the default VLAN, VLAN 1, cannot be deleted.

Adding Ethernet Ports to a VLAN

Use the **port interface_list** command to add the Ethernet ports to a VLAN.

Perform the following configuration in VLAN view.

Table 2 Adding Ethernet Ports to a VLAN

Operation	Command
Add Ethernet ports to a VLAN	**port** *interface_list*
Remove Ethernet ports from a VLAN	**undo port** *interface_list*

By default, the system adds all the ports to a default VLAN, whose ID is 1.

You can add or delete trunk port and hybrid ports to or from a VLAN by the **port** and **undo port** commands in Ethernet port view, but not in VLAN view.

Setting or Deleting the VLAN Description Character String

You can use the following command to set or delete the VLAN description character string.

You can use description character strings, such as *workgroup_name* and *department_name*, to distinguish the different VLANs.

Perform the following configuration in VLAN view.

Table 3 Setting and Deleting VLAN Description Character String

Operation	Command
Set the description character string for the specified VLAN	**description** *string*
Delete the description character string of the specified VLAN	**undo description**

By default, the VLAN description character string is the VLAN ID of the VLAN, VLAN 0001. The VLAN interface description character string is the VLAN interface name, for example, 3Com, Switch 8800, Vlan-interface1 Interface.

Specifying or Removing VLAN Interfaces

You can use the following command to specify or remove the VLAN interfaces. To implement the network layer function on a VLAN interface, the VLAN interface should be configured with an IP address and mask. For the corresponding configuration, refer to "Network Protocol Operation" on page 49.

Perform the following configurations in system view.

Table 4 Specifying and Removing VLAN interfaces

Operation	Command
Create a new VLAN interface and enter VLAN interface view	**interface vlan-interface** *vlan_id*
Remove the specified VLAN interface	**undo interface vlan-interface** *vlan_id*

Create a VLAN before creating an interface for it.

Shutting Down or Enabling a VLAN Interface

Use the following command to shut down or enable a VLAN interface.

Perform the following configuration in VLAN interface view.

Table 5 Shutting Down or Enabling a VLAN Interface

Operation	Command
Shut down the VLAN interface	**shutdown**
Enable the VLAN interface	**undo shutdown**

The operation of shutting down or enabling the VLAN interface has no effect on the UP/DOWN status of the Ethernet ports in the VLAN.

By default, when the status of all Ethernet ports in a VLAN is DOWN, the status of the VLAN interface is DOWN also so the VLAN interface is shut down. When the status of one or more Ethernet ports is UP, the status of the VLAN interface is UP also, so the VLAN interface is enabled.

Displaying and Debugging a VLAN

After the configuring a VLAN, execute the **display** command in any view to display the VLAN configuration, and to verify the effect of the configuration.

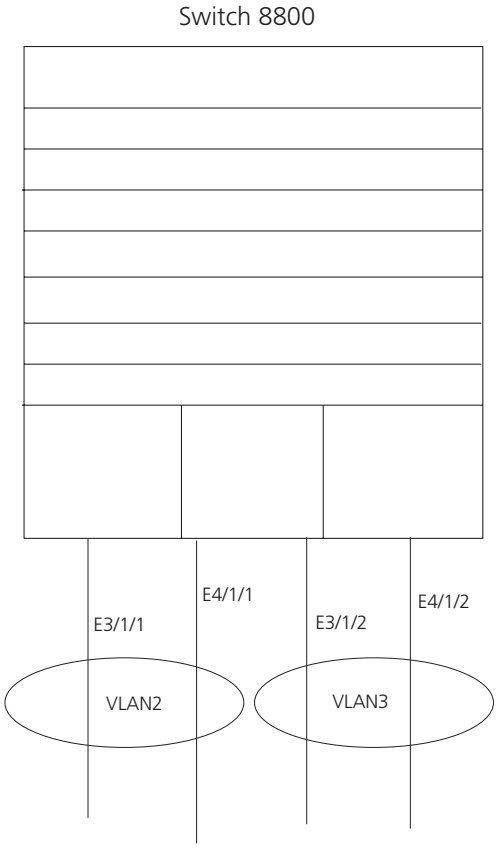
Table 6 Displaying and Debugging a VLAN

Operation	Command
Display the information about a VLAN interface	**display interface vlan-interface** [*vlan_id*]
Display the information about a VLAN	**display vlan** [*vlan_id* | **all** | **static** | **dynamic**]

Example: VLAN Configuration

Create VLAN2 and VLAN3. Add GigabitEthernet3/1/1 and GigabitEthernet4/1/1 to VLAN2 and add GigabitEthernet3/1/2 and GigabitEthernet4/1/2 to VLAN3.

Figure 1 VLAN Configuration Example



1 Create VLAN 2 and enter its view.

```
[SW8800]vlan 2
```

2 Add GigabitEthernet3/1/1 and GigabitEthernet4/1/1 to VLAN2.

```
[SW8800-vlan2]port GigabitEthernet3/1/1 GigabitEthernet4/1/1
```

3 Create VLAN 3 and enters its view.

```
[SW8800-vlan2]vlan 3
```

4 Add GigabitEthernet3/1/2 and GigabitEthernet4/1/2 to VLAN3.

```
[SW8800-vlan3]port GigabitEthernet3/1/2 GigabitEthernet4/1/2
```

Configuring GARP/GVRP

Generic Attribute Registration Protocol (GARP), allows members in the same switching network to distribute, propagate, and register information, such as VLAN and multicast addresses.

GARP does not exist in a switch as an entity. A GARP participant is called a GARP application. The main GARP applications are GVRP and GMRP. GVRP is described in Configuring GARP/GVRP and GMRP is described in "GMRP" on page 203. When a GARP participant is on a port of the switch, each port corresponds to a GARP participant.

Through GARP, configuration information on one GARP member is advertised to the entire switching network. A GARP member can be a terminal workstation or a bridge. A GARP member can notify other members to register or remove its

attribute information by sending join declarations or withdrawal declarations. It can also register or remove the attribute information of other GARP members according to the join declarations or withdrawal declarations that it receives from them.

GARP members exchange information by sending GARP messages. There are three main types of GARP messages, including join, leave, and leaveall. When a GARP participant wants to register its attribute information on other switches, it sends a join message. When the GARP participant wants to remove its attribute information from other switches, it sends a leave message. The leaveall timer is started at the same time that each GARP participant is enabled and a leaveall message is sent out when the leaveall timer times out. The join and leave messages cooperate to ensure the logout and the re-registration of a message. By exchanging messages, all the attribute information to be registered can be propagated to all the switches in the same switching network.

The destination MAC addresses of the packets of the GARP participants are specific multicast MAC addresses. A switch that supports GARP classifies the packets that it receives from GARP participants and processes them with the corresponding GARP applications (GVRP or GMRP).

GARP and GMRP are described in detail in the IEEE 802.1p standard. The Switch 8800 fully supports GARP compliant with the IEEE standards.

- *The value of the GARP timer is used in all GARP applications, including GVRP and GMRP, that are running in a switched network.*
- *In one switched network, GARP timers on all the switching devices should be set to the same value.*

Setting the GARP Timers

GARP timers include the hold, join, and leaveall timers.

The GARP participant sends join message regularly when the join timer times out so that other GARP participants can register its attribute values.

When the GARP participant wants to remove attribute values, it sends a leave message. When the leave message arrives, the receiving GARP participant starts the leave timer. If the receiving participant does not receive a join message from the sender before the leave timer expires, the receiving participant removes the sender's GARP attribute values.

The leaveall timer is started as soon as a GARP participant joins. A leaveall message is sent at timeout so that other GARP participants remove all the attribute values of this participant. Then, the leaveall timer is restarted and a new cycle begins.

When a switch receives GARP registration information, it does not send a join message immediately. Instead, it enables a hold timer and sends the join message outward when the hold timer times out. In this way, all the VLAN registration

information received within the time specified by the hold timer can be sent in one frame to save bandwidth.

Table 7 Setting the GARP Timers

Operation	Command
Configure the hold, join, and leave timers in Ethernet port view.	
Set the GARP hold, join, and leave timers	**garp timer** { **hold | join | leave** } *timer_value*
Restore the default GARP hold, join, and leave timer settings	**undo garp timer** { **hold | join | leave** }
Configure the leaveall timer in system view.	
Set GARP leaveall timer	**garp timer leaveall** *timer_value*
Restore the default GARP leaveall timer settings.	**undo garp timer leaveall**

The value of the join timer should be no less than twice the value of the hold timer, and the value of the leave timer should be greater than twice the value of the join timer and smaller than the leaveall timer value. Otherwise, the system displays an error message.

Join timer > 2 x hold timer > leave timer < leavall timer

GARP timers have the following default values:

- Hold timer — 10 centiseconds
- Join timer — 20 centiseconds,
- Leave timer — 60 centiseconds
- Leaveall timer — 1000 centiseconds.

Displaying and Debugging GARP

After you configure the GARP timer, use the **display** command in all views to display the GARP configuration, and to verify the effect of the configuration.

Execute the **reset** command in user view to reset the GARP configuration.

Execute the **debugging** command in user view to debug the GARP configuration.

Table 8 Display and Debug GARP

Operation	Command
Display GARP statistics information	**display garp statistics** [**interface** *interface-list*]
Display GARP timer	**display garp timer** [**interface** *interface-list*]
Reset GARP statistics information	**reset garp statistics** [**interface** *interface-list*]
Enable GARP event debugging	**debugging garp event**
Disable GARP event debugging	**undo debugging garp event**

Configuring GVRP

GARP VLAN Registration Protocol (GVRP) is a GARP application. GVRP is based on the GARP, and maintains the dynamic VLAN registration information in the switch and distributes the information to other switches. All the GVRP-supporting switches can receive VLAN registration information from other switches and can

dynamically update local VLAN registration information, including the active members and the port through which each member can be reached.

All the switches that support GVRP can distribute their local VLAN registration information to other switches so that VLAN information is consistent on all GVRP devices in the same network. The VLAN registration information that is distributed by GVRP includes both the local static registration information that is configured manually and the dynamic registration information received from other switches.

GVRP is described in the IEEE 802.1Q standard. The Switch 8800 fully supports GARP compliant with the IEEE standards.

GVRP configuration steps include tasks described in the following sections:

- Enabling or Disabling Global GVRP
- Enabling or Disabling Port GVRP
- Setting the GVRP Registration Type

When you configure GVRP, you need to enable it globally and for each port participating in GVRP. Similarly, the GVRP registration type can take effect only after you configure port GVRP. In addition, you must configure GVRP on the trunk port.

Enabling or Disabling Global GVRP

Use the following commands to enable or disable global GVRP.

Perform the following configurations in system view.

Table 9 Enabling/Disabling Global GVRP

Operation	Command
Enable global GVRP	**gvrp**
Disable global GVRP	**undo gvrp**

By default, GVRP is disabled on a port.

Enabling or Disabling Port GVRP

Use the following commands to enable or disable GVRP on a port.

Perform the following configurations in Ethernet port view.

Table 10 Enabling/Disabling Port GVRP

Operation	Command
Enable port GVRP	**gvrp**
Disable port GVRP	**undo gvrp**

You should enable GVRP globally before you enable it on the port. GVRP can only be enabled or disabled on a trunk port.

By default, global GVRP is disabled.

Setting the GVRP Registration Type

The GVRP includes normal, fixed, and forbidden registration types (see IEEE 802.1Q).

- When an Ethernet port registration type is set to normal, the dynamic and manual creation, registration, and logout of VLAN are allowed on this port.
- When one trunk port registration type is set to fixed, the system adds the port to the VLAN if a static VLAN is created on the switch and the trunk port allows VLAN passing. GVRP also adds this VLAN item to the local GVRP database, one link table for GVRP maintenance. However, GVRP cannot learn dynamic VLAN through this port.
- When an Ethernet port registration type is set to forbidden, all the VLANs except VLAN1 are removed and no other VLANs can be created or registered on this port.

Perform the following configurations in Ethernet port view.

Table 11 Setting the GVRP Registration Type

Operation	Command
Set GVRP registration type	**gvrp registration** { **normal | fixed | forbidden** }
Set the GVRP registration type back to the default setting	**undo gvrp registration**

By default, the GVRP registration type is normal.

Displaying and Debugging GVRP

After you set the GVRP registration type, execute the **display** command in all views to display the GVRP configuration and to verify the effect of the configuration.

Execute the **debugging** command in user view to debug the configuration of GVRP.

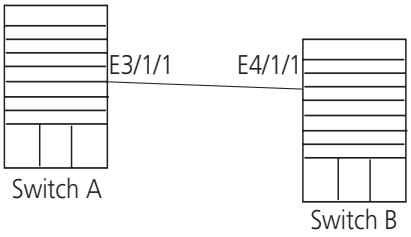
Table 12 Displaying and Debugging GVRP

Operation	Command
Display GVRP statistics information	**display gvrp statistics** [**interface** *interface-list*]
Display GVRP global status information	**display gvrp status**
Enable GVRP packet or event debugging	**debugging gvrp** { **packet | event**}
Disable GVRP packet or event debugging	**undo debugging gvrp** { **packet | event**}

Example: GVRP Configuration Example

Set network requirements to dynamically register and update VLAN information among switches.

Figure 2 GVRP Configuration Example



Configure Switch A:

1 Set GigabitEthernet3/1/1 as a trunk port and allow all the VLANs to pass through.

```
[SW8800]interface GigabitEthernet3/1/1
[SW8800-GigabitEthernet3/1/1]port link-type trunk
[SW8800-GigabitEthernet3/1/1]port trunk permit vlan all
```

2 Enable GVRP on the trunk port.

```
[SW8800-GigabitEthernet3/1/1]gvrp
```

Configure Switch B:

1 Enable GVRP globally.

```
[SW8800]gvrp
```

2 Set Gigabit Ethernet4/1/1 as a trunk port and allow all the VLANs to pass through.

```
[SW8800]interface GigabitEthernet4/1/1
[SW8800-GigabitEthernet4/1/1]port link-type trunk
[SW8800-GigabitEthernet4/1/1]port trunk permit vlan all
```

3 Enable GVRP on the trunk port.

```
[SW8800-GigabitEthernet4/1/1]gvrp
```

4 NETWORK PROTOCOL OPERATION

This chapter covers the following topics:

- Configuring IP Address
- Configuring Address Resolution Protocol (ARP)
- DHCP Relay
- IP Performance

Configuring IP Address

IP address is a 32-bit address represented by four octets. IP addresses are divided into five classes, A, B, C, D and E. The octets are set according to the first few bits of the first octet.

The rule for IP address classification is described as follows:

- Class A addresses are identified with the first bit of the first octet being 0.
- Class B addresses are identified with the first bits of the first octet being 10.
- Class C addresses are identified with the first bits of the first octet being 110.
- Class D addresses are identified with the first bits of the first octet being 1110.
- Class E addresses are identified with the first bits of the first octet being 11110.

Addresses of Classes A, B and C are unicast addresses. The Class D addresses are multicast addresses and Class E addresses are reserved for future uses.

At present, IP addresses are mostly Class A, Class B and Class C. IP addresses of Classes A, B and C are composed of two parts, network ID and host ID. Their network ID lengths are different.

- Class A IP addresses use only the first octet to indicate the network ID.
- Class B IP addresses use the first two octets to indicate the network ID.
- Class C IP addresses use the first three octets to indicate the network ID.

At most, there are: 28 =128 Class A addresses, 216=16384 Class B addresses and 224=2,097,152 Class C addresses.

The IP address is in dotted decimal format. Each IP address contains 4 integers in dotted decimal notation. Each integer corresponds to one byte, e.g.,10.110.50.101.

Configuring an IP Address is described in the following sections:

- Subnet and Mask
- Configuring an IP Address

- Troubleshooting an IP Address Configuration

Subnet and Mask

IP protocol allocates one IP address for each network interface. Multiple IP addresses can only be allocated to a device which has multiple network interfaces. IP addresses on a device with multiple interfaces have no relationship among themselves.

With the rapid development of the Internet, IP addresses are depleting very fast. The traditional IP address allocation method uses up IP addresses with little efficiency. The concept of mask and subnet was proposed to make full use of the available IP addresses.

A mask is a 32-bit number corresponding to an IP address. The number consists of 1s and 0s. Principally, these 1s and 0s can be combined randomly. However, the first consecutive bits are set to 1s when designing the mask. The mask is divided into two parts, the subnet address and host address. The 1 bits and the mask indicate the subnet address, and the other bits indicate the host address.

If there is no sub-net division, then the sub-net mask is the default value and the length of "1" indicates the net-id length. Therefore, for IP addresses of classes A, B and C, the default values of the corresponding sub-net mask is 255.0.0.0 for Class A, 255.255.0.0 for Class B, and 255.255.255.0 for Class C.

The mask can be used to divide a Class A network containing more than 16,000,000 hosts or a Class B network containing more than 60,000 hosts into multiple small networks. Each small network is called a subnet. For example, for the Class A network address 10.110.0.0, the mask 255.255.224.0 can be used to divide the network into 8 subnets: (10.110.0.0, 10.110.32.0, 10.110.64.0, and so on). Each subnet can contain more than 8000 hosts.

Configuring an IP Address

The following sections describe the tasks for configuring an IP address:

- Configure the Host IP Address and HostName for a Host
- Configuring the IP Address of the VLAN Interface
- Displaying and Debugging an IP Address

Configure the Host IP Address and HostName for a Host

This command creates correspondence between the name and the IP address of the host. When you use applications like Telnet, you can use the host name without having to memorize the IP address because the system translates the name to the IP address automatically.

Perform the following configuration in System view.

Table 1 Configure the Host Name and the Corresponding IP Address

Operation	Command
Configure the host name and the corresponding IP address	**ip host** *hostname ip-address*
Delete the host name and the corresponding IP address	**undo ip host** *hostname* [*ip-address*]

By default, there is no host name associated to any host IP address.

Configuring the IP Address of the VLAN Interface

You can configure a maximum of ten IP addresses for a VLAN interface.

Perform the following configuration in VLAN interface view.

Table 2 Configure IP Address for a VLAN Interface

Operation	Command
Configure IP address for a VLAN interface	**ip address** *ip-address net-mask* [**sub**]
Delete the IP address of a VLAN interface	**[undo] ip address** [*ip-address* { *net-mask* | *mask-length* } [**sub**]]

The network ID of an IP address is identified by the mask. For example, the IP address of a VLAN interface is 129.9.30.42 and the mask is 255.255.0.0. After performing the AND operation for the IP address and the mask, you can assign that device to the network segment 129.9.0.0.

Generally, it is sufficient to configure one IP address for an interface. However, you can also configure more than one IP address for an interface so that it can be connected to several subnets. Among these IP addresses, one is the primary IP address and all others are secondary.

By default, the IP address of a VLAN interface is null.

Displaying and Debugging an IP Address

Use the **display** command in all views to display the IP address configuration on interfaces, and to verify configuration.

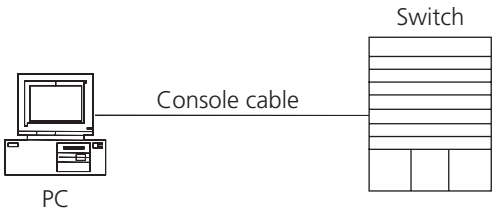
Table 3 Display and Debug IP Address

Operation	Command
Display all hosts on the network and the corresponding IP addresses	display ip hosts
Display the configurations of each interface	**display ip interface vlan-interface** *vlan-id*

Example: Configuring an IP Address

Configure the IP address as 129.2.2.1 and sub-net mask as 255.255.255.0 for the VLAN interface 1 of the Switch 8800.

Figure 1 IP Address Configuration Networking



1 Enter VLAN interface 1.

```
[SW8800]interface vlan 1
```

2 Configure the IP address for VLAN interface 1.

```
[SW8800-vlan-interface1]ip address 129.2.2.1 255.255.255.0
```

Troubleshooting an IP Address Configuration

If the Switch 8800 cannot ping a certain host on the LAN, proceed as follows:

1. Determine which VLAN includes the port connected to the host. Check whether the VLAN has been configured with the VLAN interface. Determine whether the IP address of the VLAN interface and the host are on the same network segment.
2. If the configuration is correct, enable ARP debugging on the switch from user level, and check whether or not the switch can correctly send and receive ARP packets. If it can only send but not receive the ARP packets, there are probably errors at the Ethernet physical layer.

Configuring Address Resolution Protocol (ARP)

An IP address cannot be directly used for communication between network devices, because devices can only identify MAC addresses. An IP address is the address of a host at the network layer. To send data packets through the network layer to the destination host, the physical address of the host is required. So the IP address must be resolved to a physical address.

When two hosts in Ethernet communicate, they must know each other's MAC address. Every host maintains an IP-MAC address translation table, which is known as the ARP mapping table. A series of maps between IP addresses and MAC addresses of other hosts are stored in the ARP mapping table. When a dynamic ARP mapping entry is not in use for a long time, the host will remove it from the mapping table to save memory space and shorten the search interval.

Example: IP Address Resolution

Host A and Host B are on the same network segment. The IP address of Host A is IP_A and the IP address of Host B is IP_B. Host A wants to transmit packets to Host B. Host A checks its own ARP mapping table first to make sure that there are corresponding ARP entries of IP_B in the table. If the corresponding MAC address is found, Host A will use the MAC address in the ARP mapping table to encapsulate the IP packet in an Ethernet frame and send it to Host B. If the corresponding MAC address is not found, Host A will store the IP packet in the queue waiting for transmission, and broadcast an ARP request to attempt to resolve the MAX address of Host B.

The ARP request packet contains the IP address of Host B and the IP address and MAC address of Host A. Since the ARP request packet is broadcast, all hosts on the network segment receive the request. However, only the requested host (i.e., Host B) needs to process the request. Host B will first store the IP address and the MAC address of the request sender (Host A) from the ARP request packet in its own ARP mapping table. Host B will then generate an ARP reply packet and add the MAC address of Host B before sending it to Host A. The reply packet will be sent directly to Host A instead of being broadcast. Upon receiving the reply packet, Host A will extract the IP address and the corresponding MAC address of Host B and add them to its own ARP mapping table. Then Host A will send Host B all the packets standing in the queue.

Normally, dynamic ARP executes and automatically attempts to resolve the IP address to an Ethernet MAC address with no intervention from the administrator.

Configuring ARP

The ARP mapping table can be maintained dynamically or manually. Addresses that are mapped manually are referred to as static ARP. The user can display, add, or delete the entries in the ARP mapping table through manual commands.

ARP configuration includes tasks described in the following sections:

- Manually Adding/Deleting Static ARP Mapping Entries
- Learning Gratuitous ARPs
- Configuring the Dynamic ARP Aging Timer
- Displaying and Debugging ARP

Manually Adding/Deleting Static ARP Mapping Entries

Perform the following configuration in System view.

Table 4 Manually Adding/Deleting Static ARP Mapping Entries

Operation	Command
Manually add a static ARP mapping entry	**arp static** *ip-address mac-address VLANID* { *interface_type interface_num* | *interface_name* }
Manually delete a static ARP mapping entry	**undo arp static** *ip-address*

Static ARP mapping entries will not time out, however dynamic ARP mapping entries time out after 20 minutes.

The ARP mapping table is empty and the address mapping is obtained through dynamic ARP by default.

Learning Gratuitous ARPs

Perform the following configuration in System view.

Table 5 Learning Gratuitous ARPs

Operation	Command
Enable the switch to learn gratuitous ARPs	**gratuitous-arp-learning enable**
Prevent the switch from learning gratuitous ARPs	**undo gratuitous-arp-learning enable**

By default, the switch does not learn gratuitous ARPs.

Configuring the Dynamic ARP Aging Timer

The following commands assign a dynamic ARP aging period to enable flexible configurations. When the system learns a dynamic ARP entry, its aging period is based on the currently configured value.

Perform the following configuration in system view.

Table 6 Configure the Dynamic ARP Aging Timer

Operation	Command
Configure the dynamic ARP aging timer	**arp timer aging** *aging-time*
Restore the default dynamic ARP aging time	**undo arp timer aging**

By default, the aging time of the dynamic ARP aging timer is 20 minutes.

Displaying and Debugging ARP

After the previous configuration, execute **display** command in all views to display the operation of the ARP configuration, and to verify the effect of the

configuration. Execute the **debugging** command in user view to debug the ARP configuration.

Table 7 Display and Debug ARP

Operation	Command
Display ARP mapping table	**display arp** [*ip-address* | [**static** | **dynamic**] [{ **begin** | **include** | **exclude** } *text*]]
Display the current setting of the dynamic ARP map aging timer	**display arp timer aging**
Enable ARP information debugging	**debugging arp** { **error** | **info** | **packet** }
Disable ARP information debugging	**undo debugging arp** { **error** | **info** | **packet** }

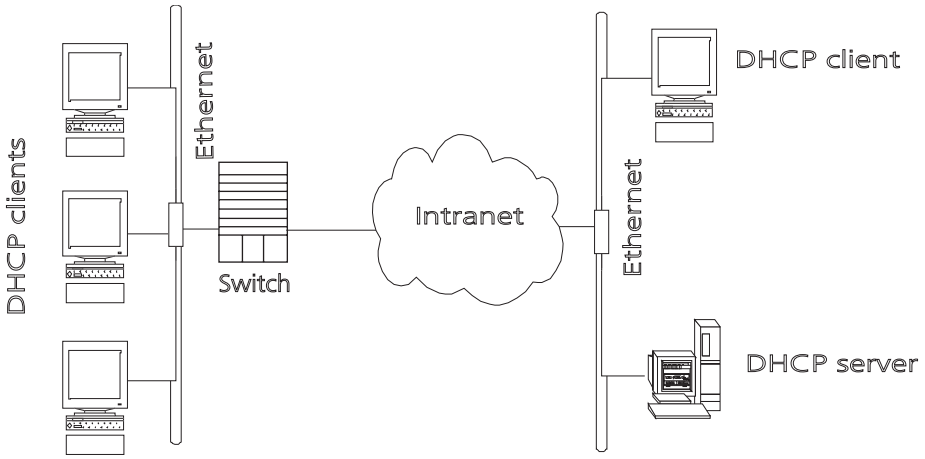
By default, all ARP mapping entries of the Ethernet switch are displayed.

DHCP Relay

Dynamic Host Configuration Protocol (DHCP) offers dynamic IP address assignment. DHCP works in Client-Server mode. With this protocol, the DHCP Client can dynamically request configuration information and the DHCP server can configure the information for the Client.

The DHCP relay serves as conduit between the DHCP Client and the server located on different subnets. The DHCP packets can be relayed to the destination DHCP server (or Client) across network segments. The DHCP clients on different networks can use the same DHCP server. This is economical and convenient for centralized management.

Figure 2 DHCP Relay Schematic Diagram



When the DHCP Client performs initialization, it broadcasts the request packet on the local network segment. If there is a DHCP server on the local network segment (e.g. the Ethernet on the right side of the figure), then the DHCP can be configured directly without the relay. If there is no DHCP server on the local network segment, DHCP relay will process the received broadcast packets and forward them to remote DHCP servers. The server configures the clients based on the information provided in the DHCP request packet and in the server setup. Then the server transmits the configuration information to the clients through the DHCP relay, thereby, completing the dynamic configuration of the client.

Configuring DHCP is described in the following sections:

- Configuring DHCP Relay
- Troubleshooting a DHCP Relay Configuration

Configuring DHCP Relay

DHCP relay configuration includes tasks described in the following sections:

- Configuring a DHCP Server IP Address in a DHCP Server Group
- Configuring the DHCP Server Group for the VLAN Interface
- Configuring the Address Table Entry
- Enabling/Disabling DHCP Security Features
- Enabling/Disabling DHCP Pseudo-server Detection
- Displaying and Debugging DHCP Relay

The server IP address is associated , through its DHCP server group, with a specific VLAN interface. This implementation differs from others in which the server IP is a global parameter.

Configuring a DHCP Server IP Address in a DHCP Server Group

You can set master and slave DHCP servers on a network segment to promote the reliability of the device. The master and slave DHCP servers form a DHCP server group. You can specify the IP addresses of the two servers using the following command.

Perform the following configuration in System view.

Table 8 Configure/Delete the IP Address of the DHCP Server

Operation	Command
Configure the IP address for a DHCP Server	**dhcp-server** *groupNo* **ip** *ipaddress1* [*ipaddress2*]
Remove all the IP addresses of the DHCP Server (set the IP addresses of the primary and secondary servers to 0).	**undo dhcp-server** *groupNo*

The backup server IP address cannot be configured independently, instead, it has to be configured together with the master server IP address.

By default, the IP address of the DHCP Server is not configured. The DHCP Server address must be configured before DHCP relay can be used.

Configuring the DHCP Server Group for the VLAN Interface

Perform the following configuration in VLAN interface view.

Table 9 Configure/Delete the Corresponding DHCP Server Group of VLAN Interface

Operation	Command
Configure the DHCP server group for the VLAN interface	**dhcp-server** *groupNo*
Delete the DHCP server group for the VLAN interface	**undo dhcp-server**

When associating a VLAN interface to a new DHCP server group, you can configure the association without disassociating it from the previous group.

By default, VLAN interfaces have no associated DHCP server group.

Configuring the Address Table Entry

To check the address of users who have valid and fixed IP addresses in the VLAN (with DHCP enabled), it is necessary to add an entry in the static address table.

Perform the following configuration in system view.

Table 10 Configure/Delete the Address Table Entry

Operation	Command
Add an entry to the address table	**dhcp-security static** *ip_address mac_address* { **dynamic** | **static** }
Delete an entry from the address table	**undo dhcp-security** { *ip_address* | **all** | **dynamic** | **static** }

Enabling/Disabling DHCP Security Features

Enabling DHCP security features starts an address check on the VLAN interface, while disabling DHCP security features cancels an address check.

Perform the following configuration in VLAN interface view.

Table 11 Enable/Disable DHCP Security on VLAN Interfaces

Operation	Command
Enable DHCP security features	**address-check enable**
Disable DHCP security features on VLAN interface	**address-check disable**

By default, DHCP security features function are disabled.

Enabling/Disabling DHCP Pseudo-server Detection

Suppose there is a DHCP server placed on a network without permission. When there is a user request for an IP address, the DHCP server will interact with the DHCP client, leading the user to get a wrong IP address. In this case, the user will be unable to access the network. Such a DHCP server is called DHCP pseudo-server.

After a DHCP pseudo-server detection-enabled, switch will record the information of the DHCP servers such as their IP addresses so that the administrator can discover the DHCP pseudo-servers.

Perform the following configuration in system view.

Table 12 Enabling and Disabling DHCP Pseudo-server Detection

Operation	Command
Enable DHCP pseudo-server detection	**dhcp-server detect**
Disable DHCP pseudo-server detection	**undo dhcp-server detect**

By default, DHCP pseudo-server detection is disabled.

Displaying and Debugging DHCP Relay

Execute **display** command in all views to display the current DHCP Relay configuration, and to verify the effect of the configuration. Execute the **debugging** command in user view to debug DHCP Relay configuration.

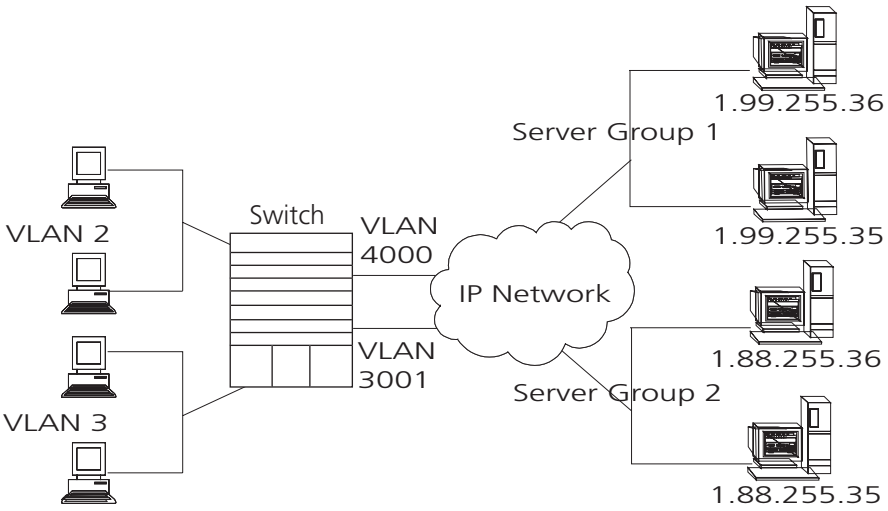
Table 13 Displaying and Debugging DHCP Relay

Operation	Command
Display the information about the DHCP server group	**display dhcp-server** *groupNo*
Display the information about the DHCP server group corresponding to the VLAN interface.	**display dhcp-server interface vlan-interface** *vlan-id*
Enable DHCP relay debugging	**debugging dhcp-relay**
Disable DHCP relay debugging	**undo debugging dhcp-relay**
Display address information for all the legal clients of the DHCP Server group.	**display dhcp-security** [*ip_address* | **dynamic** | **static**]

Example: Configuring DHCP Relay

Configure the VLAN interface corresponding to the user and the related DHCP server so as to use DHCP relay.

Figure 3 Networking Diagram of Configuring DHCP Relay



1 Configure the DHCP Server IP addresses into DHCP Server Group 1.

```
[SW8800]dhcp-server 1 ip 1.99.255.36 1.99.255.35
```

2 Associate DHCP Server Group 1 with VLAN interface 2.

```
[SW8800-VLAN-Interface2]dhcp-server 1
```

3 Configure the IP address corresponding to DHCP server group 2.

```
[SW8800]dhcp-server 2 ip 1.88.255.36 1.88.255.35
```

4 Associate the DHCP Server Group 2 with VLAN interface 3.

```
[SW8800-VLAN-Interface3]dhcp-server 2
```

5 Configure the corresponding interface and gateway address of VLAN2.

```
[SW8800]vlan 2
[SW8800-vlan2]port GigabitEthernet 1/1/2
[SW8800]interface vlan 2
[SW8800-VLAN-Interface2]ip address 1.1.2.1 255.255.0.0
```

6 Configure the corresponding interface and gateway address of VLAN3.

```
[SW8800]vlan 3
[SW8800-vlan3]port GigabitEthernet 1/1/3
[SW8800]interface vlan 3
[SW8800-VLAN-Interface3]ip address 21.2.2.1 255.255.0.0
```

7 It is necessary to configure a VLAN for the servers. The corresponding interface VLAN of the DHCP server group 1 is configured as 4000, and that of the group 2 is configured as 3001.

```
[SW8800]vlan 4000
[SW8800-vlan4000]port GigabitEthernet 1/1/4
[SW8800]interface vlan 4000
[SW8800-VLAN-Interface4000]ip address 1.99.255.1 255.255.0.0
[SW8800]vlan 3001
[SW8800-vlan3001]port GigabitEthernet 1/1/5
[SW8800]interface vlan 3001
[SW8800-VLAN-Interface3001]ip address 1.88.255.1 255.255.0.0
```

In this example, clients on VLAN2 will receive IP addresses from the servers in DHCP server group 1 (VLAN 4000). Clients on VLAN3 will receive IP addresses from the servers in DHCP server group 2 (VLAN 3001).

8 Show the configuration of DHCP server groups in User view.

```
<SW8800>display dhcp-server 1
```

9 Show the DHCP Server Group number corresponding to the VLAN interface in User view.

```
<SW8800>display dhcp-server interface vlan-interface 2
<SW8800>display dhcp-server interface vlan-interface 3
```

Troubleshooting a DHCP Relay Configuration

Perform the following procedure if a user cannot apply for an IP address dynamically:

1 Use the **display dhcp-server groupNo** command to check if the IP address of the corresponding DHCP server has been configured.

2 Use the **display VLAN** and **display IP** commands to check if the VLAN and the corresponding interface IP address have been configured.

3 Ping the configured DHCP Server to ensure that the link is connected.

4 Ping the IP address of the VLAN interface of the switch to where the DHCP user is connected from the DHCP server to make sure that the DHCP server can correctly find the route of the network segment the user is on. If the ping execution fails, check if the default gateway of the DHCP server has been configured as the address of the VLAN interface that it locates on.

5 If no problems are found in the last two steps, use the **display dhcp-server groupNo** command to view the packet that has been received. If you only see the Discover packet and there is no response packet, it means the DHCP Server has not sent the message to the Switch 8800. In this case, check if the DHCP Server has been configured properly. If the numbers of request and response packets are normal, enable the debugging dhcp-relay in User view and then use the **terminal debugging** command to output the debugging information to the console. In this way, you can view the detailed information of all DHCP packets on the console while applying for the IP address, thereby, conveniently locating the problem.

IP Performance

IP performance configuration includes:

- Configuring TCP Attributes
- Displaying and Debugging IP Performance
- Troubleshooting IP Performance

Configuring TCP Attributes

The TCP attributes that can be configured include:

- `synwait timer`: When sending the syn packets, TCP starts the synwait timer. If response packets are not received before synwait timeout, the TCP connection will be terminated. The timeout of synwait timer ranges 2 to 600 seconds and it is 75 seconds by default.
- `finwait timer`: When the TCP connection state turns from FIN_WAIT_1 to FIN_WAIT_2, finwait timer will be started. If FIN packets are not received before finwait timer timeout, the TCP connection will be terminated. Finwait ranges 76 to 3600 seconds and it is 675 seconds by default.
- The receiving/sending buffer size of connection-oriented Socket is in the range from 1 to 32K bytes and is 4K bytes by default.

Perform the following configuration in System view.

Table 14 Configure TCP Attributes

Operation	Command
Configure synwait timer time for TCP connection establishment	**tcp timer syn-timeout** *time-value*
Restore synwait timer time for TCP connection establishment to default value	**undo tcp timer syn-timeout**
Configure FIN_WAIT_2 timer time of TCP	**tcp timer fin-timeout** *time-value*
Restore FIN_WAIT_2 timer time of TCP to default value	**undo tcp timer fin-timeout**
Configure the Socket receiving/sending buffer size of TCP	**tcp window** *window-size*
Restore the socket receiving/sending buffer size of TCP to default value	**undo tcp window**

By default, the TCP finwait timer is 675 seconds, the synwait timer is 75 seconds, and the receiving/sending buffer size of connection-oriented Socket is 4K bytes.

Displaying and Debugging IP Performance

After the previous configuration, display the operation of the IP Performance configuration in all views, and verify the effect of the configuration. Execute the **debugging** command in user view to debug IP Performance configuration.

Table 15 Display and Debug IP Performance

Operation	Command
Display TCP connection state	**display tcp status**
Display TCP connection statistics data	**display tcp statistics**
Display IP statistics information	**display ip statistics**
Display ICMP statistics information	**display icmp statistics**
Display the summary of the FIB	**display fib**

Table 15 Display and Debug IP Performance

Operation	Command
Display the FIB entries matching the destination IP address (range)	**display fib** *ip_address1* [{ *mask1* | *mask-length1* } [*ip_address2* { *mask2* | *mask-length2* } | **longer**] | **longer**]
Display the FIB entries that match a specific ACL	**display fib acl** { *number* | *name* }
Display the FIB entries which are output from the buffer according to regular expression and related to the specific character string	**display fib |** { { **begin** | **include** | **exclude** } *text* }
Display the FIB entries matching the specific prefix list	**display fib ip-prefix** *listname*
Display the total number of FIB entries	**display fib statistics**
Reset IP statistics information	**reset ip statistics**
Reset TCP statistics information	**reset tcp statistics**

Troubleshooting IP Performance

If the IP layer protocol works normally, but TCP and UDP do not work normally, you can enable the corresponding debugging information output to view the debugging information.

- Use the **terminal debugging** command to output the debugging information to the console.
- Use the **debugging udp packet** command to enable the UDP debugging to trace the UDP packet. When the router sends or receives UDP packets, the content format of the packet can be displayed in real time. You can locate the problem from the contents of the packet.

  The following are the UDP packet formats:

```
UDP output packet:
Source IP address:202.38.160.1
Source port:1024
Destination IP Address 202.38.160.1
Destination port: 4296
```

- Use the **debugging tcp packet** or **debugging tcp transaction** command to enable the TCP debugging to trace the TCP packets. There are two available ways for debugging TCP.
- Debug and trace the packets of the TCP connection that take this device as one end.

  Operations include:

```
<SW8800>terminal debugging
<SW8800>debugging tcp packet
```

  The TCP packets, received or sent can be checked in real time. Specific packet formats include:

```
TCP output packet:
Source IP address:202.38.160.1
Source port:1024
Destination IP Address 202.38.160.1
Destination port: 4296
Sequence number :4185089
Ack number: 0
Flag  :SYN
```

```
Packet length :60
Data offset: 10
```

- Debug and trace the packets located in SYN, FIN or RST.

  Operations include:

```
<SW8800>terminal debugging
<SW8800>debugging tcp transact
```

  The TCP packets received or sent can be checked in real time, and the specific packet formats are the same as those mentioned above.

IPX Configuration

Internetwork Packet Exchange (IPX) protocol is a network layer protocol in the NetWare protocol suite. It is similar to IP in the TCP/IP protocol suite. IPX functions to address, route and forward packets.

IPX is a connectionless protocol. Though an IPX packet includes a destination IPX address in addition to the data, there is no guarantee of successful delivery. Packet acknowledgement and connection control must be provided by protocols above IPX. Each IPX packet is considered an independent entity that has no logical or sequential relationship with any other IPX packets.

IPX Address Structure

IPX and IP use different address structures. An IPX address comprises two parts: the network number and the node address; it is in the format of network.node.

A network number identifies the network where a site is located. It is four bytes long and expressed by eight hexadecimal numbers. A node address identifies a node on the network. Like a MAC address, it is six bytes long and written with the bytes being separated into three 2-byte parts by "-". The node address cannot be a broadcast or multicast address. For example, in the IPX address bc.0-0cb-47, bc (or 000000bc) is the network number and 0-0cb-47 (0000-00cb-0047) is the node address. You can also write an IPX address in the form of N.H-H-H, where N is the network number and H-H-H is the node address.

Routing Information Protocol

IPX uses the Routing Information Protocol (RIP) to maintain and advertise dynamic routing information. With IPX enabled, the switch exchanges routing information with other neighbors through RIP to maintain an internetwork routing information database (also known as a routing table) to accommodate to the network changes. When the switch receives a packet, it looks up the routing table for the next site and if there is any, forwards the packet. The routing information can be configured statically or collected dynamically.

This chapter introduces RIP in IPX. For the RIP configurations on an IP network, refer to the routing protocol section in this manual.

Service Advertising Protocol

The Service Advertising Protocol (SAP) advertises the services provided by servers and their addresses. It is used by IPX to maintain and advertise dynamic service information. With SAP, a server broadcasts its services when it starts and the termination of the services when it goes down.

With IPX enabled, the switch creates and maintains an internetwork service information database (or the service information table) through SAP. It helps you learn what services are available on the networks and where they are provided.

The servers periodically broadcast their services and addresses to the networks directly connected to them. Users cannot use such information directly, however. Instead, the information is collected by the SAP agents of the switches on the networks and saved in their server information tables.

5 IP ROUTING PROTOCOL OPERATION

This chapter covers the following topics:

- IP Routing Protocol Overview
- Static Routes
- RIP
- OSPF
- IS-IS
- BGP
- IP Routing Policy
- Route Capacity

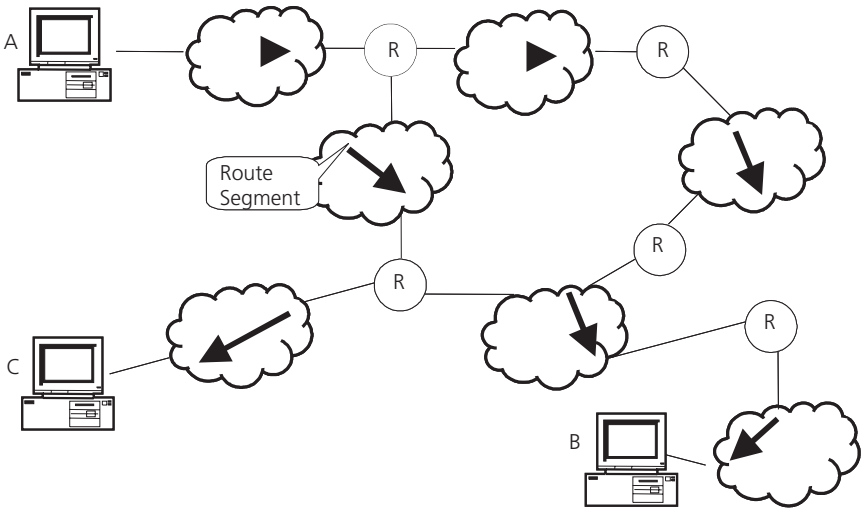
IP Routing Protocol Overview

Routers select an appropriate path through a network for an IP packet according to the destination address of the packet. Each router on the path receives the packet and forwards it to the next router. The last router in the path submits the packet to the destination host.

In a network, the router regards a path for sending a packet as a logical route unit, and calls it a hop. For example, in Figure 1, a packet sent from Host A to Host C goes through 3 networks and 2 routers and the packet is transmitted through two hops and router segments. Therefore, when a node is connected to another node through a network, there is a hop between these two nodes and these two nodes are considered adjacent in the Internet. Adjacent routers are two routers connected to the same network. The number of route segments between a router and hosts in the same network count as zero. In Figure 1, the bold arrows represent the hops. A router can be connected to any physical link that constitutes a route segment for routing packets through the network.

When a switch runs a routing protocol, it can perform router functions. In this guide, a router and its icon represent a generic router or a switch running routing protocols.

Figure 1 About Hops



Networks can have different sizes, so, the segment lengths connected between two different pairs of routers are also different.

If a router in a network is regarded as a node and a route segment in the Internet is regarded as a link, message routing in the Internet works in a similar way as the message routing in a conventional network. Routing a message through the shortest route may not always be the optimal route. For example, routing through three LAN route segments may be much faster than a route through two WAN route segments.

Configuring the IP Routing Protocol Overview is described in the following sections:

- Selecting Routes Through the Routing Table
- Routing Management Policy

Selecting Routes Through the Routing Table

For the router, a routing table is the key to forwarding packets. Each router saves a routing table in its memory, and each entry in this table specifies the physical port of the router through which a packet is sent to a subnet or a host. The packet can reach the next router over a particular path or reach a destination host through a directly connected network.

A routing table has the following key entries:

- A destination address — Identifies the destination IP address or the destination network of the IP packet, which is 32 bits in length.
- A network mask — Is made up of several consecutive 1s, which can be expressed either in the dotted decimal format, or by the number of the consecutive 1s in the mask. Combined with the destination address, the network mask identifies the network address of the destination host or router. With the destination address and the network mask, you have the address of the network segment where the destination host or router is located. For example, if the destination address is 129.102.8.10, the address of the network where the host or the router with the mask 255.255.0.0 is located is 129.102.0.0.

- The output interface — Indicates an interface through which an IP packet should be forwarded.
- The next hop address — Indicates the next router that an IP packet will pass through.
- The priority added to the IP routing table for a route — Indicates the type of route that is selected. There may be multiple routes with different next hops to the same destination. These routes can be discovered by different routing protocols, or they can be the static routes that are configured manually. The route with the highest priority (the smallest numerical value) is selected as the current optimal route.

Types of routes are divided into the following types, subnet routes, in which the destination is a subnet, or host routes, in which the destination is a host.

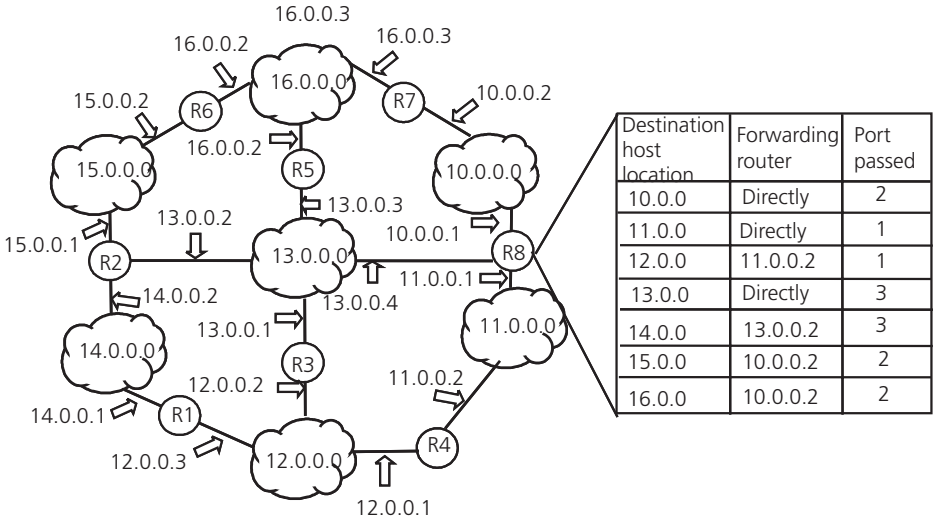
In addition, depending on whether the network of the destination host is directly connected to the router, there are the following types of routes:

- Direct route: The router is directly connected to the network where the destination is located.
- Indirect route: The router is not directly connected to the network where the destination is located.

To limit the size of the routing table, an option is available to set a default route. All the packets that fail to find a suitable table entry are forwarded through this default route.

In a complicated Internet, as shown in the following figure, the number in each network is the network address. The router R8 is connected to three networks, so it has three IP addresses and three physical ports. Its routing table is shown in Figure 2.

Figure 2 The Routing Table



Destination host location	Forwarding router	Port passed
10.0.0	Directly	2
11.0.0	Directly	1
12.0.0	11.0.0.2	1
13.0.0	Directly	3
14.0.0	13.0.0.2	3
15.0.0	10.0.0.2	2
16.0.0	10.0.0.2	2

Routing Management Policy

The Switch 8800 supports the configuration of a series of dynamic routing protocols such as RIP, OSPF, as well as static routes. The static routes configured by

the user are managed together with the dynamic routes as detected by the routing protocol. The static routes and the routes learned or configured by routing protocols can be shared with each other.

Routing protocols (as well as the static configuration) can generate different routes to the same destination, but not all these routes are optimal. In fact, at a certain moment, only one routing protocol can determine a current route to a single destination. Thus, each routing protocol (including the static configuration) has a set preference, and when there are multiple routing information sources, the route discovered by the routing protocol with the highest preference becomes the current route. Routing protocols and the default preferences (the smaller the value, the higher the preference) of the routes that they learn are shown in Table 1.

Table 1 Routing Protocols and the Default Preferences for Routes

Routing protocol or route type	The preference of the corresponding route
DIRECT	0
OSPF	10
ISIS	15
STATIC	60
RIP	100
OSPF ASE	150
OSPF NSSA	150
IBGP	256
EBGP	256
UNKNOWN	255

In the table, 0 indicates a direct route, and 255 indicates any route from an unreliable source.

Except for direct routing and BGP (IBGP and EBGP), the preferences of various dynamic routing protocols can be manually configured to meet the user requirements. The preferences for individual static routes can be different.

Supporting Load Sharing and Route Backup

The Switch 8800 supports load sharing and route backup.

Load sharing is supported by configuring multiple routes that reach the same destination and use the same precedence. The same destination can be reached by multiple different paths, whose precedences are equal. When there is no route that can reach the same destination with a higher precedence, the multiple routes will be adopted by IP, which will forward the packets to the destination by these paths to implement load sharing.

Route backup allows the system to automatically switch to a backup route when main route has failed to improve network reliability.

To achieve route backup, the user can configure multiple routes to the same destination according to actual situation. One of the routes has the highest precedence and is called as main route. The other routes have descending precedence and are called backup routes. Normally, the router sends data by the

main route. When the line fails, the main route hides itself and the router chooses one from the remaining routes as a backup route whose precedence is higher than others' to send data. When the main route recovers, the router restores it and re-selects a route. As the main route has the highest precedence, the router chooses the main route to send data. This process is the automatic switchover from the backup route to the main route.

For the same destination, a specified routing protocol may find multiple different routes. If the routing protocol has the highest precedence among all active routing protocols, these multiple routes will be regarded as currently valid routes. Thus, load sharing of IP traffic is ensured in terms of routing protocols. The Switch 8800 supports four routes to implement load sharing.

Routes Shared Between Routing Protocols

As the algorithms of various routing protocols are different, different protocols can generate different routes. This situation creates the problem of how to resolve different routes being generated by different routing protocols. The Switch 8800 supports an operation to import the routes generated by one routing protocol into another routing protocol. Each protocol has its own route redistribution mechanism. For details, refer to "Enabling RIP to Import Routes of Other Protocols", "Configuring OSPF to Import the Routes of Other Protocols", or "Importing Routing Information Discovered by Other Routing Protocols".

Static Routes

A static route is a route that is manually configured by the network administrator. You can set up an interconnected network using static routes. However, if a fault occurs in the network, the static route cannot change automatically to steer packets away from the fault without the help of the administrator.

In a relatively simple network, you only need to configure static routes to make the router work normally. The proper configuration and usage of the static route can improve network performance and ensure bandwidth for important applications.

The following routes are static routes:

- Reachable route — The normal route in which the IP packet is sent to the next hop towards the destination. It is a common type of static route.
- Unreachable route — When a static route to a destination has the *reject* attribute, all the IP packets to this destination are discarded, and the originating host is informed that the destination is unreachable.
- Blackhole route — When a static route to a destination has the *blackhole* attribute, all the IP packets to this destination are discarded, and the originating host is not informed.

The attributes *reject* and *blackhole* are usually used to control the range of reachable destinations of this router, and to help troubleshoot the network.

Default Route

A default route is also a static route. A default route is used only when no suitable routing table entry is found. In a routing table, the default route is in the form of the route to the network 0.0.0.0 (with the mask 0.0.0.0). You can determine whether a default route has been set by viewing the output of the **display ip routing-table** command. If the destination address of a packet fails to match any

entry of the routing table, the router selects the default route to forward this packet. If there is no default route and the destination address of the packet fails to match any entry in the routing table, the packet is discarded, and an Internet Control Message Protocol (ICMP) packet is sent to the originating host to indicate that the destination host or network is unreachable.

In a typical network that consists of hundreds of routers, if you used multiple dynamic routing protocols without configuring a default route then significant bandwidth would be consumed. Using the default route can provide appropriate bandwidth, but not high bandwidth, for communications between large numbers of users.

Configuring Static Routes is described in the following sections:

- Configuring Static Routes
- Troubleshooting Static Routes

Configuring Static Routes

Static route configuration tasks are described in the following sections:

- Configuring a Static Route
- Configuring a Default Route
- Deleting All Static Routes
- Displaying and Debugging Static Routes

Configuring a Static Route

Perform the following configurations in system view.

Table 2 Configuring a Static Route

Operation	Command
Add a static route	**ip route-static** *ip-address* {*mask* | *mask-length* } { *interface-name* | *gateway-address* } [**preference** *value*] [**reject** | **blackhole**]
Delete a static route	**undo ip route-static** *ip-address* {*mask* | *mask-length* } { *interface-name* | *gateway-address*} [**preference** *value*]

The parameters are explained as follows:

- IP address and mask

  The IP address and mask use a decimal format. Because the 1s in the 32-bit mask must be consecutive, the dotted decimal mask can also be replaced by the mask-length which refers to the digits of the consecutive 1s in the mask.

- Transmitting interface or next hop address

  When you configure a static route, you can specify either the interface-type port-number to designate a transmitting interface, or the gateway-address to decide the next hop address, depending on the actual conditions.

You can specify the transmitting interfaces in the cases below:

- For the interface that supports resolution from the network address to the link layer address (such as the Ethernet interface that supports ARP), when ip-address and mask (or mask-length) specifies a host address, and this

destination address is in the directly connected network, the transmitting interface can be specified.

- For a P2P interface, the address of the next hop defines the transmitting interface because the address of the opposite interface is the address of the next hop of the route.

  In fact, for all routing items, the next hop address must be specified. When the IP layer transmits a packet, it first searches the matching route in the routing table, depending on the destination address of the packet. Only when the next hop address of the route is specified, can the link layer find the corresponding link layer address, and then forward the packet.

- For different configurations of preference-value, you can flexibly apply the routing management policy.

- The *reject* and *blackhole* attributes indicate the unreachable route and the blackhole route.

Configuring a Default Route

Perform the following configurations in system view.

Table 3 Configuring a Default Route

Operation	Command
Configure a default route	**ip route-static** 0.0.0.0 { 0.0.0.0 | 0 } { *interface-name* | *gateway-address* } [**preference** *value*] [**reject** | **blackhole**]
Delete a default route	**undo ip route-static** 0.0.0.0 { 0.0.0.0 | 0 } { *interface-name* | *gateway-address* }]

Parameters for default route are the same as for static route.

Deleting All Static Routes

You can use the **undo ip route-static** command to delete one static route. The Switch 8800 also provides the **delete static-route all** command for you to delete all static routes at one time, including the default routes.

Perform the following configuration in system view.

Table 4 Deleting All Static Routes

Operation	Command
Delete all static routes	**delete static-routes all**

Displaying and Debugging Static Routes

After you configure static and default routes, execute the **display** command in all views, to display the static route configuration, and to verify the effect of the configuration.

Table 5 Displaying and Debugging the Routing Table

Operation	Command
View routing table summary	**display ip routing-table**
View routing table details	**display ip routing-table verbose**
View the detailed information of a specific route	**display ip routing-table** *ip-address*

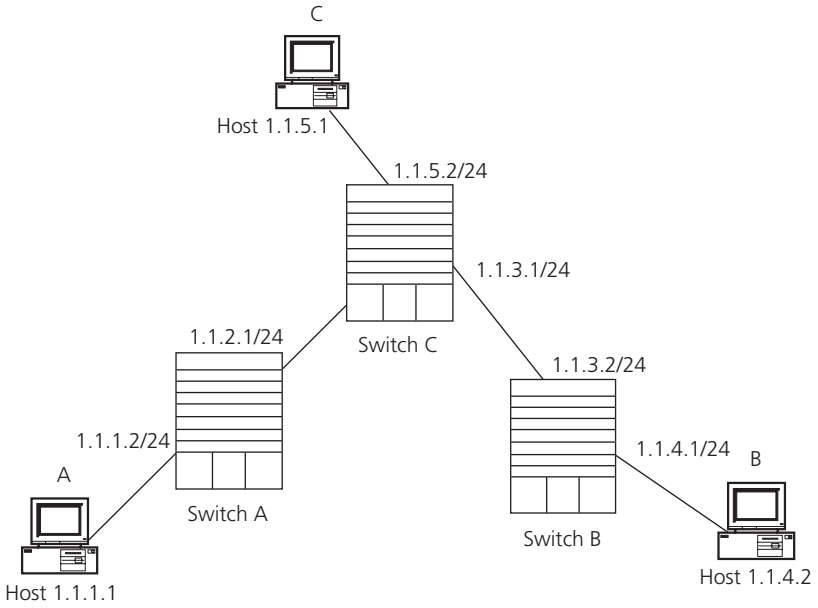
Table 5 Displaying and Debugging the Routing Table

Operation	Command
View the route filtered through specified basic access control list (ACL)	**display ip routing-table acl** { *acl-number* | *acl-name* } [**verbose**]
View the route information that through specified ip prefix list	**display ip routing-table ip-prefix** *ip-prefix-number* [**verbose**]
View the routing information found by the specified protocol	**display ip routing-table protocol** *protocol* [**inactive** | **verbose**]
View the tree routing table	**display ip routing-table radix**
View the integrated routing information	**display ip routing-table statistics**

Example: Typical Static Route Configuration

As shown in the Figure 3, the masks of all the IP addresses in the figure are 255.255.255.0. All the hosts or switches must be interconnected in pairs, by configuring static routes.

Figure 3 Static Route Configuration



1 Configure the static route for Switch A:

```
[Switch A]ip route-static 1.1.3.0 255.255.255.0 1.1.2.2
[Switch A]ip route-static 1.1.4.0 255.255.255.0 1.1.2.2
[Switch A]ip route-static 1.1.5.0 255.255.255.0 1.1.2.2
```

2 Configure the static route for Switch B:

```
[Switch B]ip route-static 1.1.2.0 255.255.255.0 1.1.3.1
[Switch B]ip route-static 1.1.5.0 255.255.255.0 1.1.3.1
[Switch B]ip route-static 1.1.1.0 255.255.255.0 1.1.3.1
```

3 Configure the static route for Switch C:

```
[Switch C]ip route-static 1.1.1.0 255.255.255.0 1.1.2.1
[Switch C]ip route-static 1.1.4.0 255.255.255.0 1.1.3.2
```

4 Configure the default gateway of the Host A to be 1.1.5.2

5 Configure the default gateway of the Host B to be 1.1.4.1

6 Configure the default gateway of the Host C to be 1.1.1.2

Using this procedure, all the hosts or switches in Figure 3 can be interconnected in pairs.

Troubleshooting Static Routes

The Switch 8800 is not configured with any dynamic routing protocols enabled. Both the physical status and the link layer protocol status of the interface are enabled, but the IP packets cannot be forwarded normally.

- Use the **display ip routing-table protocol static** command to view whether the corresponding static route is correctly configured.
- Use the **display ip routing-table** command to view whether the corresponding route is valid.

RIP

Routing Information Protocol (RIP) is a simple, dynamic routing protocol, that is Distance-Vector (D-V) algorithm-based. It uses hop counts to measure the distance to the destination host, which is called routing cost. In RIP, the hop count from a router to its directly connected network is 0. The hop count to a network which can be reached through another router is 1, and so on. To restrict the time to converge, RIP prescribes that the cost value is an integer that ranges from 0 to 15. The hop count equal to or exceeding 16 is defined as infinite, or the destination network or host is unreachable.

RIP exchanges routing information using UDP packets. RIP sends a routing refresh message every 30 seconds. If no routing refresh message is received from one network neighbor in 180 seconds, RIP tags all routes of the network neighbor as unreachable. If no routing refresh message is received from one network neighbor in 300 seconds, RIP removes the routes of the network neighbor from the routing table. RIP v2 has the MD5 cipher authentication function while RIP v1 does not.

To improve performance and avoid routing loops, RIP supports split horizon, poison reverse, and allows for importing routes discovered by other routing protocols.

Each router that is running RIP manages a route database, which contains routing entries to all the reachable destinations in the network. These routing entries contain the following information:

- Destination address — The IP address of a host or network.
- Next hop address — The address of the next router that an IP packet will pass through to reach the destination.
- Output interface — The interface through which the IP packet should be forwarded.
- Cost — The cost for the router to reach the destination, which should be an integer in the range of 0 to 15.
- Timer — The length of time from the last time that the routing entry was modified until now. The timer is reset to 0 whenever a routing entry is modified.
- Route tag — The indication whether the route is generated by an interior routing protocol, or by an exterior routing protocol.

The whole process of RIP startup and operation can be described as follows:

1. If RIP is enabled on a router for the first time, the router broadcasts a request packet to adjacent routers. When they receive the request packet, adjacent routers (on which RIP is also enabled) respond to the request by returning response packets containing information about their local routing tables.
2. After receiving the response packets, the router that sent the request modifies its own routing table.
3. RIP broadcasts its routing table to adjacent routers every 30 seconds. The adjacent routers maintain their own routing tables after receiving the packets and elect an optimal route, then advertise the modification information to their adjacent network to make the updated route globally available. Furthermore, RIP uses timeout mechanism to handle timed-out routes to ensure the timeliness and validity of the routes. With these mechanisms, RIP, an interior routing protocol, enables the router to learn the routing information of the entire network.

RIP has become one of the most popular standards of transmitting router and host routes. It can be used in most campus networks and regional networks that are simple, yet extensive. RIP is not recommended for larger and more complicated networks.

Configuring RIP is described in the following sections:

- Configuring RIP
- Troubleshooting RIP

Configuring RIP

Only after RIP is enabled can other functional features be configured. But the configuration of the interface-related functional features is not dependent on whether RIP has been enabled.

After RIP is disabled, the interface-related features also become invalid.

The RIP configuration tasks are described in the following sections:

- Enabling RIP and Entering the RIP View
- Enabling the RIP Interface
- Configuring Unicast RIP Messages
- Specifying the RIP Version
- Configuring RIP Timers
- Configuring RIP-1 Zero Field Check of the Interface Packet
- Specifying the Operating State of the Interface
- Disabling Host Route
- Enabling RIP-2 Route Aggregation
- Setting RIP-2 Packet Authentication
- Configuring Split Horizon
- Enabling RIP to Import Routes of Other Protocols
- Configuring the Default Cost for the Imported Route
- Setting the RIP Preference

- Setting Additional Routing Metrics
- Configuring Route Filtering
- Displaying and Debugging RIP

Enabling RIP and Entering the RIP View

Perform the following configurations in system view.

Table 6 Enabling RIP and Entering the RIP View

Operation	Command
Enable RIP and enter the RIP view	**rip**
Disable RIP	**undo rip**

By default, RIP is not enabled.

Enabling the RIP Interface

For flexible control of RIP operation, you can specify the interface and configure the network where it is located in the RIP network, so that these interfaces can send and receive RIP packets.

Perform the following configurations in RIP view.

Table 7 Enabling RIP Interface

Operation	Command
Enable RIP on the specified network interface	**network** *network-address*
Disable RIP on the specified network interface	**undo network** *network-address*

After the RIP interface is enabled, you should also specify its operating network segment, because RIP only operates on the interface when the network segment has been specified. RIP does not receive or send routes for an interface that is not on the specified network, and does not forward its interface route.

The *network-address* parameter is the address of the enabled or disabled network, and it can also be configured as the IP network address of the appropriate interfaces.

When a **network** command is used for an address, the effect is to enable the interface of the network with the address. For example, for **network** *129.102.1.1*, you can see **network** *129.102.0.0* using either the **display current-configuration** command or the **display rip** command.

Configuring Unicast RIP Messages

RIP is a broadcast protocol. To exchange route information with the non-broadcast network, the unicast transmission mode must be adopted.

Perform the following configuration in the RIP view.

Table 8 Configuring Unicast RIP Messages

Operation	Command
Configure unicast RIP messages	**peer** *ip-address*
Cancel unicast RIP messages	**undo peer** *ip-address*

By default, RIP does not send messages to unicast addresses.

Usually, this command is not recommended because the opposite side does not need to receive two of the same messages at a time. It should be noted that the **peer** command should also be restricted by the **rip work**, **rip output**, **rip input** and **network** commands.

Specifying the RIP Version

RIP has two versions, RIP-1 and RIP-2. You can specify the version of the RIP packet processed by the interface.

RIP-1 broadcasts the packets. RIP-2 can transmit packets by both broadcast and multicast. By default, multicast is adopted for transmitting packets. In RIP-2, the default multicast address is 224.0.0.9. The advantage of transmitting packets in the multicast mode is that the hosts in the same network that do not run RIP, do not receive RIP broadcast packets. In addition, this mode prevents the hosts that are running RIP-1 from incorrectly receiving and processing the routes with subnet mask in RIP-2. When an interface is running RIP-2, it can also receive RIP-1 packets.

Perform the following configuration in VLAN interface view.

Table 9 Specifying RIP Version of the Interface

Operation	Command
Specify the interface version as RIP-1	**rip version 1**
Specify the interface version as RIP-2	**rip version 2** [**broadcast** | **multicast**]
Restore the default RIP version running on the interface	**undo rip version** { **1 | 2** }

By default, the interface receives and sends RIP-1 packets. It transmits packets in multicast mode when the interface RIP version is set to RIP-2.

Configuring RIP Timers

As stipulated in RFC1058, RIP is controlled by three timers, period update, timeout, and garbage-collection:

- Period update is triggered periodically to send all RIP routes to all the neighbors.
- If a RIP route has not been updated when the timeout timer expires, the route will be considered unreachable.
- If the garbage-collection timer times out before the unreachable route is updated by the update packets from the neighbors, the route will be deleted completely from the routing table.

Modification of these timers can affect the convergence speed of RIP.

Perform the following configuration in RIP view.

Table 10 Configuring RIP Timers

Operation	Command
Configure RIP timers	**timers** { **update** *update-timer-length* | **timeout** *timeout-timer-length* }*
Restore the default settings of RIP	**undo timers** { **update** | **timeout** } *

The modification of RIP timers takes effect immediately.

By default, the values of period update and timeout timers are 30 seconds and 180 seconds. The value of garbage-collection timer is four times that of period update timer, 120 seconds.

In fact, you may find that the timeout time of garbage-collection timer is not fixed. If period update timer is set to 30 seconds, garbage-collection timer might range from 90 to 120 seconds.

Before RIP completely deletes an unreachable route from the routing table, it advertises the route by sending four update packets with route metric of 16, to let all the neighbors knows that the route is unreachable. Routes do not always become unreachable when a new period starts so the actual value of the garbage-collection timer is 3 to 4 times the value of the period update timer.

You must consider network performance when adjusting RIP timers, and configure all the routes that are running RIP, to avoid unnecessary traffic or network oscillation.

Configuring RIP-1 Zero Field Check of the Interface Packet

According to the RFC1058, some fields in the RIP-1 packet must be 0. When an interface version is set to RIP-1, the zero field check must be performed on the packet. If the value in the zero field is not zero, processing is refused. There are no zero fields in RIP-2 packets so configuring a zero field check is invalid for RIP-2.

Perform the following configurations in RIP view.

Table 11 Configuring Zero Field Check of the Interface Packet

Operation	Command
Configure zero field check on the RIP-1 packet	**checkzero**
Disable zero field check on the RIP-1 packet	**undo checkzero**

By default, RIP-1 performs zero field check on the packet.

Specifying the Operating State of the Interface

In the VLAN interface view, you can specify whether RIP update packets are sent and received on the interface. In addition, you can specify whether an interface sends or receives RIP update packets.

Perform the following configuration in VLAN interface view.

Table 12 Specifying the Operating State of the Interface

Operation	Command
Enable the interface to run RIP	**rip work**
Disable RIP on the interface	**undo rip work**
Enable the interface to receive RIP update packets	**rip input**
Disable receipt of RIP update packets on the interface	**undo rip input**
Enable the interface to send RIP update packets	**rip output**
Disable transmission of RIP packets on the interface	**undo rip output**

The **rip work** command is functionally equivalent to both **rip input** and **rip output** commands.

By default, all interfaces except loopback interfaces both receive and transmit RIP update packets.

Disabling Host Route

In some cases, the router can receive many host routes from the same segment, and these routes are of little help in route addressing but consume a lot of network resources. Routers can be configured to reject host routes by using **undo host-route** command.

Perform the following configurations in RIP view.

Table 13 Disabling Host Routes

Operation	Command
Enable receiving host routes	**host-route**
Disable receiving host routes	**undo host-route**

By default, the router receives the host route.

Enabling RIP-2 Route Aggregation

Route aggregation means that different subnet routes in the same natural network can be aggregated into one natural mask route for transmission when they are sent to other outside networks. Route aggregation can be performed to reduce the routing traffic on the network, as well as to reduce the size of the routing table.

RIP-1 only sends the routes with natural mask, that is, it always sends routes in the route aggregation form.

RIP-2 supports subnet mask and classless inter-domain routing. To advertise all the subnet routes, the route aggregation function of RIP-2 can be disabled.

Perform the following configurations in RIP view.

Table 14 Enabling Route Aggregation

Operation	Command
Enable the automatic aggregation function of RIP-2	**summary**
Disable the automatic aggregation function of RIP-2	**undo summary**

By default, RIP-2 uses the route aggregation function.

Setting RIP-2 Packet Authentication

RIP-1 does not support packet authentication. However, you can configure packet authentication on RIP-2 interfaces.

RIP-2 supports two authentication modes:

- Simple authentication — This mode does not ensure security. The key is not encrypted and can be seen in a network trace so simple authentication should not be applied when there are high security requirements
- MD5 authentication — This mode uses two packet formats: One format follows RFC1723 (RIP Version 2 Carrying Additional Information); the other format follows RFC2082 (RIP-2 MD5 Authentication).

Perform the following configuration in VLAN interface view

Table 15 Setting RIP-2 Packet Authentication

Operation	Command
Configure RIP-2 simple authentication key	**rip authentication-mode simple** *password-string*
Configure RIP-2 MD5 authentication with packet type following RFC 1723	**rip authentication-mode { simple** *password* **| md5 { usual** *key-string* **| nonstandard** *key-string key-id } }*
Configure RIP-2 MD5 authentication with packet type following RFC 2082	**rip authentication-mode { simple** *password* **| md5 { usual** *key-string* **| nonstandard** *key-string key-id } }*
Set the packet format type of RIP-2 MD5 authentication	**rip authentication-mode { simple** *password* **| md5 { usual** *key-string* **| nonstandard** *key-string key-id } }*
Cancel authentication of RIP-2 packet	**undo rip authentication-mode**

The **usual** packet format follows RFC1723 and **nonstandard** follows RFC2082.

Configuring Split Horizon

Split horizon means that the route received through an interface will not be sent through this interface again. The split horizon algorithm can reduce the generation of routing loops, but in some special cases, split horizon must be disabled to obtain correct advertising at the cost of efficiency. Disabling split horizon has no effect on the P2P connected links but is applicable on the Ethernet.

Perform the following configuration in VLAN interface view.

Table 16 Configuring Split Horizon

Operation	Command
Enable split horizon	**rip split-horizon**
Disable split horizon	**undo rip split-horizon**

By default, split horizon of the interface is enabled.

Enabling RIP to Import Routes of Other Protocols

RIP allows users to import the route information of other protocols into the routing table.

RIP can import direct, static, OSPF, BGP, and IS-IS routes.

BGP and IS-IS require the advanced version of the software on the Switch 8800.

Perform the following configurations in RIP view.

Table 17 Enabling RIP to Import Routes of Other Protocols

Operation	Command
Enable RIP to import routes of other protocols	**import-route** *protocol* [**cost** *value*] [**route-policy** *route-policy-name*]
Disable route imports from other protocols	**undo import-route** *protocol*

By default, RIP does not import the route information of other protocols.

Configuring the Default Cost for the Imported Route

When you use the **import-route** command to import the routes of other protocols, you can specify their cost. If you do not specify the cost of the imported route, RIP will set the cost to the default cost, specified by the default cost parameter.

Perform the following configurations in RIP view.

Table 18 Configuring the Default Cost for the Imported Route

Operation	Command
Configure default cost for the imported route	**default cost** *value*
Restore the default cost of the imported route.	**undo default cost**

By default, the cost value for the RIP imported route is 1.

Setting the RIP Preference

Each routing protocol has its own preference by which the routing policy selects the optimal one from the routes of different protocols. The greater the preference value, the lower the preference. The preference of RIP can be set manually.

Perform the following configurations in RIP view.

Table 19 Setting the RIP Preference

Operation	Command
Set the RIP Preference	**preference** *value*
Restore the default value of RIP preference	**undo preference**

By default, the preference of RIP is 100.

Setting Additional Routing Metrics

The additional routing metric, is the input or output routing metric added to a RIP route. It does not change the metric value of the route in the routing table, but adds a specified metric value when the interface receives or sends a route.

Perform the following configuration in VLAN interface view.

Table 20 Setting Additional Routing Metric

Operation	Command
Set the additional routing metric of the route when the interface receives an RIP packet	**rip metricin** *value*
Disable the additional routing metric of the route when the interface receives an RIP packet	**undo rip metricin**
Set the additional routing metric of the route when the interface sends an RIP packet	**ip metricout** *value*
Disable the additional routing metric of the route when the interface sends an RIP packet	**undo rip metricout**

By default, the additional routing metric added to the route when RIP sends the packet is 1. The additional routing metric when RIP receives the packet is 0.

Configuring Route Filtering

The router provides the route filtering function. You can configure the filter policy rules by specifying the ACL and ip-prefix for route redistribution and distribution. To import a route, the RIP packet of a specific router can also be received by designating a neighbor router.

Perform the following configurations in RIP view.

Table 21 Configuring RIP to Filter Routes

Operation	Command
Configure filtering the received routing information distributed by the specified address	**filter-policy gateway** ip-prefix-name **import**
Cancel filtering the received routing information distributed by the specified address	**undo filter-policy gateway** *ip-prefix-name* **import**
Configure filtering the received global routing information	**filter-policy** { *acl-number* | **ip-prefix** *ip-prefix-name* } **import**
Cancel filtering the received global routing information	**undo filter-policy** { *acl-number* | **ip-prefix** *ip-prefix-name* } **import**

By default, RIP does not filter received and distributed routing information.

Displaying and Debugging RIP

After configuring RIP, execute the **display** command in all views to display the RIP configuration, and to verify the effect of the configuration. Execute the **debugging** command in user view to debug the RIP module. Execute the **reset** command in RIP view to reset the system configuration parameters of RIP.

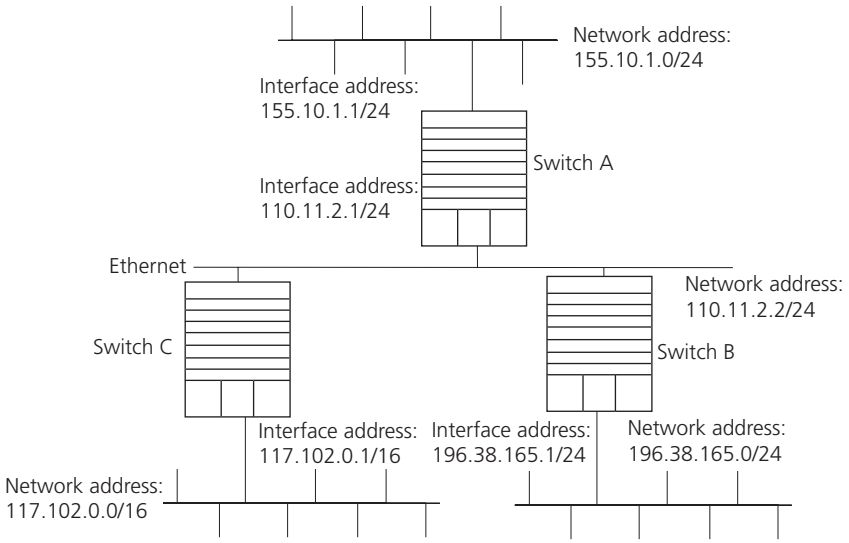
Table 22 Displaying and Debugging RIP

Operation	Command
Display the current RIP state and configuration information.	**display rip**
Enable the RIP debugging information	**debugging rip packets**
Enable the debugging of RIP receiving packet.	**debugging rip receive**
Enable the debugging of RIP sending packet.	**debugging rip send**
Restore the default RIP settings	**reset**

Example: Typical RIP Configuration

As shown in Figure 4, the Switch C connects to the subnet 117.102.0.0 through the Ethernet port. The Ethernet ports of Switch A and Switch B are connected to the network 155.10.1.0 and 196.38.165.0. Switch C, Switch A, and Switch B are connected by Ethernet 110.11.2.0. Correctly configure RIP to ensure that Switch C, Switch A, and Switch B can interconnect.

Figure 4 RIP Configuration



The following configuration only shows the operations related to RIP. Before performing the following configuration, verify that the Ethernet link layer works normally.

1 Configure RIP on Switch A:

```
[Switch A]rip
[Switch A-rip]network 110.11.2.0
[Switch A-rip]network 155.10.1.0
```

2 Configure RIP on Switch B:

```
[Switch B]rip
[Switch B-rip]network 196.38.165.0
```

```
[Switch B-rip]network 110.11.2.0
```

3 Configure RIP on Switch C:

```
[Switch C]rip
[Switch C-rip]network 117.102.0.0
[Switch C-rip]network 110.11.2.0
```

Troubleshooting RIP

The Switch 8800 cannot receive update packets when the physical connection to the peer routing device is normal.

- RIP does not operate on the corresponding interface (for example, if the **undo rip work** command is executed) or this interface is not enabled through the **network** command.
- The peer routing device is configured for multicast mode (for example, the **rip version 2 multicast** command is executed) but the multicast mode has not been configured on the corresponding interface of the local switch.

OSPF

Open Shortest Path First (OSPF) is an Interior Gateway Protocol (IGP). At present, OSPF version 2 (RFC2328) is used, which has the following features:

- Scope — Supports networks of various sizes and can support several hundred routers
- Fast convergence — Transmits the update packets instantly after the network topology changes so the change is synchronized in the AS
- Loop-free — Calculates routes using the shortest path tree algorithm, according to the collected link states so that no loop routes are generated from the algorithm itself
- Area partition — Allows the network of AS to be divided into different areas for management convenience, so that the routing information that is transmitted between the areas is further abstracted to reduce network bandwidth consumption
- Equal-cost multi-route — Supports multiple equal-cost routes to a destination
- Routing hierarchy — Supports a four-level routing hierarchy that prioritizes routes into intra-area, inter-area, external type-1, and external type-2 routes.
- Authentication — Supports the interface-based packet authentication to guarantee the security of the route calculation
- Multicast transmission — Uses multicast addresses to send updates.

Configuring OSPF is described in the following sections:

- Calculating OSPF Routes
- Configuring OSPF
- Troubleshooting OSPF

Calculating OSPF Routes

The OSPF protocol calculates routes in the following way:

- Each OSPF-capable router maintains a Link State Database (LSD), which describes the topology of the entire AS. According to the network topology around itself, each router generates a Link State Advertisement (LSA). The routers on the network transmit the LSAs among themselves by transmitting

the protocol packets to each other. Thus, each router receives the LSAs of other routers and all these LSAs constitute its LSD.

- LSA describes the network topology around a router, so the LSD describes the network topology of the entire network. Routers can easily transform the LSD to a weighted directed graph, which actually reflects the topology of the whole network. All the routers have the same graph.
- A router uses the SPF algorithm to calculate the shortest path tree which shows the routes to the nodes in the autonomous system. In this tree, the router is the root. The external routing information is a leaf node. A router that advertises the routes, also tags them and records the additional information of the autonomous system. Therefore, the routing tables obtained from different routers are different.

OSPF supports interface-based packet authentication to guarantee the security of route calculation. OSPF also transmits and receives packets by IP multicast.

OSPF Packets

OSPF uses five types of packets:

- Hello Packet

  The Hello packet is the most common packet sent by the OSPF protocol. A router periodically sends it to its neighbor. It contains the values of some timers, DR, BDR and the known neighbor.

- Database Description (DD) Packet

  When two routers synchronize their databases, they use the DD packets to describe their own Link State Databases (LSDs), including the digest of each LSA. The digest refers to the HEAD of an LSA, which can be used to uniquely identify the LSA. Synchronizing databases with DD packets reduces the traffic size transmitted between the routers, since the HEAD of an LSA only occupies a small portion of the overall LSA traffic. With the HEAD, the peer router can judge whether it has already received the LSA.

- Link State Request (LSR) Packet

  After exchanging the DD packets, the two routers know which LSAs of the peer routers are missing from the local LSD's. In this case, they send LSR packets to the peers, requesting the missing LSAs. The packets contain the digests of the missing LSAs.

- Link State Update (LSU) Packet

  The LSU packet is used to transmit the needed LSAs to the peer router. It contains a collection of multiple LSAs (complete contents).

- Link State Acknowledgment (LSAck) Packet

  The packet is used for acknowledging received LSU packets. It contains the HEAD(s) of LSA(s) requiring acknowledgement.

Basic Concepts Related to OSPF

- Router ID

  To run OSPF, a router must have a router ID. If no ID is configured, the system automatically selects an IP address from the IP addresses of the current interface as the router ID.

- Designated Router (DR)

  In a broadcast network, in which all routers are directly connected, any two routers must establish adjacency to broadcast their local status information to the whole AS. In this situation, every change that a router makes results in multiple transmissions, which is not only unnecessary but also wastes bandwidth. To solve this problem, OSPF defines a "designated router" (DR). All routers send information only to the DR for broadcasting the network link states to the network. This reduces the number of router adjacent relations on the multi-access network.

  When the DR is not manually specified, the DR is elected by all the routers in the segment. See "Setting the Interface Priority for DR Election"

- Backup Designated Router (BDR)

  If the DR fails, a new DR must be elected and synchronized with the other routers on the segment. This process takes a relatively long time, during which the route calculation is incorrect. To shorten the process, OSPF creates a BDR as backup for the DR. A new DR and BDR are elected in the meantime. The adjacencies are also established between the BDR and all the routers on the segment, and routing information is also exchanged between them. After the existing DR fails, the BDR becomes a DR immediately.

- Area

  If all routers on a large network are running OSPF, the large number of routers results in an enormous LSD, which consumes storage space, complicates the SPF algorithm, and adds CPU. Furthermore, as a network grows larger, the topology becomes more likely to change. Hence, the network is always in "turbulence", and a large number of OSFP packets are generated and transmitted in the network. This shrinks network bandwidth. In addition, each change causes all the routers on the network to recalculate the routes.

  OSPF solves this problem by dividing an AS into different areas. Areas logically group the routers, which form the borders of each area. Thus, some routers may belong to different areas. A router that connects the backbone area and a non-backbone area is called an area border router (ABR). An ABR can connect to the backbone area physically or logically.

- Backbone Area

  After the area division of OSPF, one area is different from all the other areas. Its area-id is 0 and it is usually called the backbone area.

- Virtual link

  Since all the areas should be connected logically, virtual link is adopted so that the physically separated areas can still maintain logical connectivity.

- Route summary

  An AS is divided into different areas that are interconnected through OSPF ABRs. The routing information between areas can be reduced by use of a route summary. Thus, the size of routing table can be reduced and the calculation speed of the router can be improved. After finding an intra-area route of an area, the ABR looks in the routing table and encapsulates each OSPF route into an LSA and sends it outside the area.

Configuring OSPF

You must first enable OSPF then specify the interface and area ID before configuring other functions. However, the configuration of functions that are related to the interface does not depend on whether OSPF is enabled. However, if OSPF is disabled, the OSPF-related interface parameters become invalid.

OSPF configuration includes tasks that are described in the following sections:

- Enabling OSPF and Entering OSPF View
- Entering OSPF Area View
- Specifying the Interface
- Configuring Router ID
- Configuring the Network Type on the OSPF Interface
- Configuring the Cost for Sending Packets on an Interface
- Setting the Interface Priority for DR Election
- Setting the Peer
- Setting the Interval of Hello Packet Transmission
- Setting a Dead Timer for the Neighboring Routers
- Configuring an Interval Required for Sending LSU Packets
- Setting an Interval for LSA Retransmission Between Neighboring Routers
- Setting a Shortest Path First (SPF) Calculation Interval for OSPF
- Configuring the OSPF STUB Area
- Configuring NSSA of OSPF
- Configuring the Route Summarization of OSPF Area
- Configuring OSPF Virtual Link
- Configuring Summarization of Imported Routes by OSPF
- Configuring the OSPF Area to Support Packet Authentication
- Configuring OSPF Packet Authentication
- Configuring OSPF to Import the Routes of Other Protocols
- Configuring Parameters for OSPF to Import External Routes
- Configuring OSPF to Import the Default Route
- Setting OSPF Route Preference
- Configuring OSPF Route Filtering
- Configuring Filling the MTU Field When an Interface Transmits DD Packets
- Disabling the Interface to Send OSPF Packets
- Configuring OSPF and Network Management System (NMS)
- Resetting the OSPF Process
- Displaying and Debugging OSPF

Enabling OSPF and Entering OSPF View

Perform the following configurations in system view.

Table 23 Enabling the OSPF Process

Operation	Command
Enable the OSPF process	**ospf** [*process-id* [[**router-id** *router-id*]]
Disable the OSPF process	**undo ospf** [*process-id*]

By default, OSPF is not enabled.

Entering OSPF Area View

Perform the following configurations in OSPF view.

Table 24 Entering OSPF Area View

Operation	Command
Enter an OSPF area view	**area** *area-id*
Delete a designated OSPF area	**undo area** *area-id*

Specifying the Interface

OSPF divides the AS into different areas. You must configure each OSPF interface to belong to a particular area, identified by an area ID. The areas transfer routing information between them through the ABRs.

In addition, parameters of all the routers in the same area should be identical. Therefore, when configuring the routers in the same area, please note that most configurations should be based on the area. An incorrect configuration can disable the neighboring routers from transmitting information, and lead to congestion or self-loop of the routing information.

Perform the following configuration in OSPF Area view.

Table 25 Specifying Interface

Operation	Command
Specify an interface to run OSPF	**network** *ip-address ip-mask*
Disable OSPF on the interface	**undo network** *ip-address ip-mask*

You must specify the segment to which the OSPF will be applied after enabling the OSPF tasks.

Configuring Router ID

A router ID is a 32-bit unsigned integer that uniquely identifies a router within an AS. A router ID can be configured manually. If a router ID is not configured, the system selects the IP address of an interface automatically. When you set a router ID manually, you must guarantee that the IDs of any two routers in the AS are unique. A common undertaking is to make the router ID the same as the IP address of an interface on the router.

Perform the following configurations in system view.

Table 26 Configuring Router ID

Operation	Command
Configure router ID	**router id** *router-id*
Remove the router ID	**undo router id**

To ensure the stability of OSPF, you must determine the division of router IDs and manually configure them when implementing network planning.

Configuring the Network Type on the OSPF Interface

The route calculation of OSPF is based on the topology of the adjacent network of the local router. Each router describes the topology of its adjacent network and transmits it to all the other routers.

OSPF divides networks into four types by link layer protocol:

- Broadcast: If Ethernet or FDDI is adopted, OSFP defaults the network type to broadcast.
- Non-Broadcast Multi-access (NBMA): If Frame Relay, ATM, HDLC or X.25 is adopted, OSPF defaults the network type to NBMA.
- Point-to-Multipoint (P2MP): OSPF does not default the network type of any link layer protocol to P2MP. The general undertaking is to change a partially connected NBMA network to P2MP network, if the NBMA network is not fully-meshed.
- Point-to-point (P2P): If PPP, LAPB or POS is adopted, OSPF defaults the network type to P2P.

As you configure the network type, consider the following points:

- NBMA means that a network is non-broadcast and multi-accessible. ATM is a typical example. You can configure the polling interval for hello packets before the adjacency of neighboring routers is formed.
- Configure the interface type to nonbroadcast on a broadcast network without multi-access capability.
- Configure the interface type to P2MP if not all the routers are directly accessible on an NBMA network.
- Change the interface type to P2P if the router has only one peer on the NBMA network.

The differences between NBMA and P2MP are listed below:

- In OSPF, NBMA refers to the networks that are fully connected, non-broadcast and multi-accessible. However, a P2MP network is not required to be fully connected.
- DR and BDR are required on a NBMA network but not on a P2MP network.
- NBMA is the default network type. For example, if ATM is adopted as the link layer protocol, OSPF defaults the network type on the interface to NBMA, regardless of whether the network is fully connected. P2MP is not the default network type. No link layer protocols are regarded as P2MP. You must change

the network type to P2MP manually. The most common method is to change a partially connected NBMA network to a P2MP network.

- NBMA forwards packets by unicast and requires neighbors to be configured manually. P2MP forward packets by multicast.

Perform the following configuration in VLAN interface view.

Table 27 Configuring a Network Type on the Interface that Starts OSPF

Operation	Command
Configure network type on the interface	**ospf network-type** { **broadcast | NBMA | P2MP | P2P** }
Restore the default network type of the OSPF interface	**undo ospf network-type**

After the interface has been configured with a new network type, the original network type is removed automatically.

Configuring the Cost for Sending Packets on an Interface

The user can control the network traffic by configuring different message sending costs for different interfaces. Otherwise, OSPF automatically calculates the cost according to the baud rate on the current interface.

Perform the following configuration in VLAN interface view.

Table 28 Configuring the Cost for Sending Packets on the Interface

Operation	Command
Configure the cost for sending packets on interface	**ospf cost** *value*
Restore the default cost for packet transmission on the interface	**undo ospf cost**

Setting the Interface Priority for DR Election

The priority of the router interface determines the qualification of the interface for DR election. A router of higher priority is considered first if there is a collision in the election.

DR is not designated manually, instead, it is elected by all the routers on the segment. Routers with priorities > 0 in the network are eligible candidates. Among all the routers self-declared to be the DR, the one with the highest priority is elected. If two routers have the same priority, the one with the highest router ID is elected DR. Each router writes the expected DR in the packet and sends it to all the other routers on the segment. If two routers attached to the same segment concurrently declare themselves to be the DR, the one with the higher priority wins. If the priorities are the same, the router with higher router ID wins. If the priority of a router is 0, it is not eligible to be elected DR or BDR.

If a DR fails, the routers on the network must elect a new DR and synchronize with the new DR. The process takes a relatively long time, during which, route calculation can become incorrect. To speed up this DR replacement process, OSPF implements the BDR as a backup for DR. The DR and BDR are elected at the same time. The adjacencies are also established between the BDR and all the routers on the segment, and routing information is exchanged between them. When the DR

fails, the BDR becomes the DR instantly. Since no re-election is needed and the adjacencies have already been established, the process is very short. But in this case, a new BDR must be elected. Although it also takes a long time, it does not affect the route calculation.

Note that:

- The DR on the network is not necessarily the router with the highest priority. Likewise, the BDR is not necessarily the router with the second highest priority. If a new router is added after DR and BDR election, it is impossible for the router to become the DR even if it has the highest priority.
- The DR is based on the router interface in a certain segment. Maybe a router is a DR on one interface, but it can be a BDR or DROther on another interface.
- DR election is only required for broadcast or NBMA interfaces. For the P2P or P2MP interfaces, DR election is not required.

Perform the following configuration in VLAN interface view.

Table 29 Setting the Interface Priority for DR Election

Operation	Command
Configure the interface with a priority for DR election	**ospf dr-priority** *priority_num*
Restore the default interface priority	**undo ospf dr-priority**

By default, the priority of the interface is 1 in the DR election. The value can be set from 0 to 255.

Setting the Peer

For an NBMA network, some special configurations are required. Since an NBMA interface on the network cannot discover the adjacent router through broadcasting the Hello packets, you must manually specify an IP address for the adjacent router of the interface, and whether the adjacent router is eligible for election. This can be done by configuring the **peer ip-address** command. If *dr-priority-number* is not specified, the adjacent router will be regarded as ineligible.

Perform the following configuration in OSPF view.

Table 30 Configuring the Peer

Operation	Command
Configure a peer for the NBMA interface.	**peer** *ip-address* [**dr-priority** *dr-priority-number*]
Remove the configured peer for the NBMA interface	**undo peer** *ip-address*

By default, the preference for the neighbor of NBMA interface is 1.

Setting the Interval of Hello Packet Transmission

Hello packets are the most frequently sent packets. They are periodically sent to the adjacent router for discovering and maintaining adjacency, and for electing a DR and BDR. The user can set the hello timer.

According to RFC2328, the consistency of hello intervals between network neighbors should be kept. The hello interval value is in inverse proportion to the route convergence rate and network load.

Perform the following configuration in VLAN interface view.

Table 31 Setting Hello Timer and Poll Interval

Operation	Command
Set the hello interval of the interface	**ospf timer hello** *seconds*
Restore the default hello interval of the interface	**undo ospf timer hello**
Set the poll interval on the NBMA interface	**ospf timer poll** *seconds*
Restore the default poll interval	**undo ospf timer poll**

By default, P2P and broadcast interfaces send Hello packets every 10 seconds, and P2MP and NBMA interfaces send the packets every 30 seconds.

Setting a Dead Timer for the Neighboring Routers

If hello packets are not received from a neighboring router, that router is considered dead. The dead timer of neighboring routers refers to the interval after which a router considers a neighboring router dead. You can set a dead timer for the neighboring routers.

Perform the following configuration in VLAN interface view.

Table 32 Setting a Dead Timer for the Neighboring Routers

Operation	Command
Configure a dead timer for the neighboring routers	**ospf timer dead** *seconds*
Restore the default dead interval of the neighboring routers	**undo ospf timer dead**

By default, the dead interval for the neighboring routers of P2P or broadcast interfaces is 40 seconds and for the neighboring routers of P2MP or NBMA interfaces is 120 seconds.

Both hello and dead timers restore the default values if you modify the network type.

Configuring an Interval Required for Sending LSU Packets

Trans-delay seconds should be added to the aging time of the LSA in an LSU packet. Setting the parameter like this, the time duration that the interface requires for transmitting the packet, is considered.

You can configure the interval for sending LSU messages. More attention should be paid to this item on low speed networks.

Perform the following configuration in VLAN interface view.

Table 33 Configuring an Interval for LSU packets

Operation	Command
Configure an interval for sending LSU packets	**ospf trans-delay** *seconds*
Restore the default interval of sending LSU packets	**undo ospf trans-delay**

By default, LSU packets are transmitted by seconds.

Setting an Interval for LSA Retransmission Between Neighboring Routers

If a router transmits an LSA to the peer, it requires the acknowledgement packet from the peer. If it does not receive the acknowledgement packet within the retransmission, it retransmits this LSA to the neighbor. You can configure the value of the retransmission interval.

Perform the following configuration in VLAN interface view.

Table 34 Setting Retransmit Timer

Operation	Command
Configure the interval of LSA retransmission for the neighboring routers	**ospf timer retransmit** *interval*
Restore the default LSA retransmission interval for the neighboring routers	**undo ospf timer retransmit**

By default, the interval for neighboring routers to retransmit LSAs is five seconds.

The value of the interval should be bigger than the interval in which a packet can be transmitted and returned between two routers.

An LSA retransmission interval that is too small will cause unnecessary retransmission.

Setting a Shortest Path First (SPF) Calculation Interval for OSPF

Whenever the OSPF LSDB changes, the shortest path requires recalculation. Calculating the shortest path after a change consumes enormous resources and affects the operating efficiency of the router. Adjusting the SPF calculation interval, however, can restrain the resource consumption caused by frequent network changes.

Perform the following configuration in OSPF view.

Table 35 Setting the SPF Calculation Interval

Operation	Command
Set the SPF calculation interval	**spf-schedule-interval** *seconds*
Restore the SPF calculation interval	**undo spf-schedule-interval** *seconds*

By default, the interval for SPF recalculation is 5 seconds.

Configuring the OSPF STUB Area

STUB areas are special LSA areas in which the ABRs do not propagate the learned external routes of the AS. In these areas, the routing table sizes of routers and the routing traffic are significantly reduced.

The STUB area is an optional configuration attribute, but not every area conforms to the configuration condition. Generally, STUB areas, located at the AS boundaries, are those non-backbone areas with only one ABR. Even if this area has multiple ABRs, no virtual links are established between these ABRs.

To insure that routes to the destinations outside the AS are still reachable, the ABR in this area generates a default route (0.0.0.0) and advertises it to the non-ABR routers in the area.

Note the following items when you configure a STUB area:

- The backbone area cannot be configured as a STUB area, and virtual links cannot pass through the STUB area.
- If you want to configure an area as a STUB area, all the routers in this area should be configured with the **stub** command.
- No ASBR can exist in a STUB area and the external routes of the AS cannot be propagated in the STUB area.

Perform the following configuration in OSPF Area view.

Table 36 Configuring an OSPF STUB Area

Operation	Command
Configure an area as the STUB area	**stub** [**no-summary**]
Remove the configured STUB area	**undo stub**
Set the cost of the default route to the STUB area	**default-cost** *value*
Remove the cost of the default route to the STUB area	**undo default-cost**

By default, the STUB area is not configured, and the cost of the default route to a STUB area is 1.

Configuring NSSA of OSPF

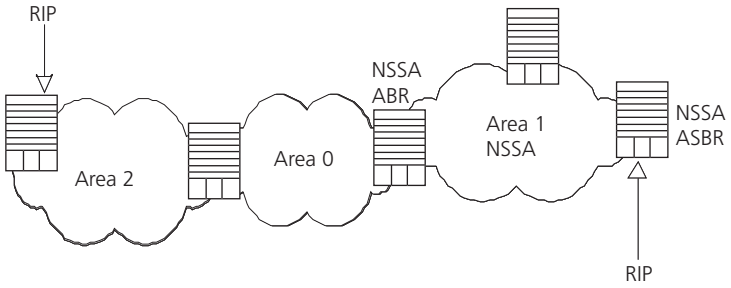
An NSSA is similar to a STUB area. However, NSSA does not allow importing AS-External-LSAs (type-5 LSAs) although it does allow importing NSSA-External-LSAs (type-7 LSAs). ASBRs can be configured to convert type-5 LSAs to type-7 LSAs to allow advertising of type-5 LSAs within the NSSA. Similarly, ABRs can be configured to reconvert the type-7 LSAs to type-5 LSAs as these LSAs leave the NSSA.

For example, in Figure 5, the AS running OSPF includes three areas: Area 1, Area 2 and Area 0. Among them, Area 0 is the backbone area. Also, there are other two ASs running RIP. Area 1 is defined as an NSSA. After RIP routes of Area 1 are propagated to the NSSA ASBR, the NSSA ASBR generates type-7 LSAs which are propagated in Area 1. When the type-7 LSAs reach the NSSA ABR, the NSSA ABR translates it into a type-5 LSA, which is propagated to Area 0 and Area 2. On the other hand, RIP routes of the AS running RIP are translated into type-5 LSAs that

are propagated in the OSPF AS. However, the type-5 LSAs do not reach Area 1 because Area 1 is an NSSA. NSSAs and STUB areas have the same approach in this aspect.

Similar to a STUB area, the NSSA cannot be configured with virtual links.

Figure 5 NSSA



Perform the following configuration in OSPF Area view.

Table 37 Configuring NSSA of OSPF

Operation	Command
Configure an area to be the NSSA area	**nssa** [**default-route-advertise**] [**no-import-route**] [**no-summary**]
Cancel the configured NSSA	**undo nssa**
Configure the default cost value of the route to the NSSA	**default-cost** *cost*
Restore the default cost value of the route to the NSSA area	**undo default-cost**

All routers connected to the NSSA must use the **nssa** command to configure the area with the NSSA attribute.

The **default-route-advertise** parameter is used to generate the default type-7 LSAs. The default type-7 LSA route is generated on the ABR, even though the default route 0.0.0.0 is not in the routing table. On an ASBR, however, the default type-7 LSA route can be generated only if the default route 0.0.0.0 is in the routing table.

Executing the **no-import-route** command on the ASBR prevents the external routes that OSPF imported through the import-route command from advertising to the NSSA. Generally, if an NSSA router is both ASBR and ABR, this argument is used.

The **default-cost** command is used on the ABR attached to the NSSA. Using this command, you can configure the default route cost on the ABR to NSSA.

By default, the NSSA is not configured, and the cost of the default route to the NSSA is 1.

Configuring the Route Summarization of OSPF Area

Route summary means that ABR can aggregate information of the routes of the same prefix and advertise only one route to other areas. An area can be configured with multiple aggregate segments allowing OSPF to summarize them.

When the ABR transmits routing information to other areas, it generates Sum_net_Lsa (type-3 LSA) per network. If some continuous networks exist in this area, you can use the **abr-summary** command to summarize these segments into one segment. Thus, the ABR only needs to send an aggregate LSA, and all the LSAs in the range of the aggregate segment specified by the command are not transmitted separately. Therefore, the sizes of the LSDBs in other areas can be reduced.

Once the aggregate segment of a certain network is added to the area, all the internal routes of the IP addresses in the range of the aggregate segment are no longer separately broadcast to other areas. Only the route summary of the whole aggregate network is advertised. However, if the range of the segment is restricted by the **not-advertise** keyword, the route summary of this segment is not advertised. This segment is represented by an IP address and mask. The receiving and restriction of the aggregate segment can reduce the routing traffic exchanged between the areas.

Route summarization can take effect only when it is configured on ABRs.

Perform the following configuration in OSPF Area view.

Table 38 Configuring the Route Summarization of an OSPF Area

Operation	Command
Configure the Route Summarization of OSPF Area	**abr-summary** *ip-address mask* [**advertise** | **not-advertise**]
Cancel route summarization of OSPF Area	**undo abr-summary** *ip-address mask*

By default, the inter-area routes are not summarized.

Configuring OSPF Virtual Link

According to RFC2328, after the area division of OSPF, the backbone is established with an area-id of 0.0.0.0. The OSPF routes between non-backbone areas are updated with the help of the backbone area. OSPF stipulates that all the non-backbone areas should maintain connectivity with the backbone area, and at least one interface on the ABR should fall into the area 0.0.0.0. If an area does not have a direct physical link with the backbone area 0.0.0.0, a virtual link must be created.

If physical connectivity cannot be made due to network topology restrictions, a virtual link can be used to meet the requirements of RFC 2328. The virtual link refers to a logic channel set up through the area of a non-backbone internal route between two ABRs. The two ends of the channel should be ABRs and the connection can take effect only when both ends are configured. The virtual link is identified by the ID of the remote router. The area, which provides the ends of the virtual link with a non-backbone area internal route, is called the transit area. The ID of the transit area should be specified during configuration.

The virtual link is activated after the route passing through the transit area is calculated, which is equivalent to a P2P connection between two ends. Therefore, similar to the physical interfaces, you can also configure various interface parameters on this link, such as a hello timer.

The "logic channel" means that the multiple routers running OSPF between two ABRs only take the role of packet forwarding (the destination addresses of the protocol packets are not these routers, so these packets are transparent to them and the routers forward them as common IP packets). The routing information is directly transmitted between the two ABRs. The routing information refers to the type-3 LSAs generated by the ABRs, for which the synchronization mode of the routers in the area is not changed.

Perform the following configuration in OSPF area view.

Table 39 Configuring OSPF Virtual Link

Operation	Command
Create and configure a virtual link	**vlink-peer** *router-id* [**hello** *seconds* | **retransmit** *seconds* | **trans-delay** *seconds* | **dead** *seconds* | **simple** *password* | **md5** *keyid key*]*
Remove the created virtual link	**undo vlink-peer** *router-id*

The *area-id* and *router-id* variables have no default value.

By default, the hello timer is 10 seconds, retransmit is 5 seconds, trans-delay is 1 second, and the dead timer is 40 seconds.

Configuring Summarization of Imported Routes by OSPF

The OSPF implementation in the Switch 8800 supports route summarization of imported routes.

Perform the following configurations in OSPF view.

Table 40 Configuring Summarization of Imported Routes by OSPF

Operation	Command
Configure summarization of imported routes by OSPF	**asbr-summary** *ip-address mask* [**not-advertise** | **tag** *value*]
Remove summarization of routes imported into OSPF	**undo asbr-summary** *ip-address mask*

By default, summarization of imported routes is disabled.

After the summarization of imported routes is configured, if the local router is an autonomous system border router (ASBR), this command summarizes the imported Type-5 LSAs in the summary address range. When NSSA is configured, this command also summarizes the imported Type-7 LSA in the summary address range.

If the local router works as an ABR and a router in the NSSA, this command summarizes Type-5 LSAs transformed from Type-7 LSAs. If the router is not the router in the NSSA, the summarization is disabled.

Configuring the OSPF Area to Support Packet Authentication

All the routers in an area should use the same authentication type. All the routers on the same segment should use the same authentication-key password. Use the **authentication-mode simple** command to configure the simple authentication

password for the area and the **authentication-mode md5** command to configure the MD5 authentication-key password.

Perform the following configuration in OSPF Area view.

Table 41 Configuring the OSPF Area to Support Packet Authentication

Operation	Command
Configure the area to support authentication type	**authentication-mode** [**simple** | **md5**]
Cancel the configured authentication key	**undo authentication-mode**

By default, the area does not support packet authentication.

Configuring OSPF Packet Authentication

OSPF supports simple authentication or MD5 authentication between neighboring routers.

Perform the following configuration in VLAN interface view.

Table 42 Configuring OSPF Packet Authentication

Operation	Command
Enable the interface to use simple authentication	**ospf authentication-mode simple** *password*
Disable simple authentication on the interface	**undo ospf authentication-mode simple**
Enable the interface to use MD5 authentication	**ospf authentication-mode md5** *key_id key*
Disable the use of MD5 authentication on the interface	**undo ospf authentication-mode md5**

By default, the interface is not configured with either simple authentication or MD5 authentication.

Configuring OSPF to Import the Routes of Other Protocols

The dynamic routing protocols on the router can share the routing information. As far as OSPF is concerned, the routes discovered by other routing protocols are always processed as the external routes of AS. In the **import-route** commands, you can specify the route cost type, cost value and tag to overwrite the default route receipt parameters (see "Configuring Parameters for OSPF to Import External Routes").

The OSPF uses the following four types of routes (in priority):

- Intra-area route
- Inter-area route
- External route type 1
- External route type 2

Intra-area and inter-area routes describe the internal AS topology whereas the external route describes how to select the route to the destinations beyond the AS.

The external type-1 routes refer to imported IGP routes (such as static route and RIP). Since these routes are more reliable, the calculated cost of the external routes is the same as the cost of routes within the AS. Also, this route cost and the route cost of the OSPF itself are comparable. That is, the cost to reach the external route type 1 equals the cost to reach the corresponding ASBR from the local router plus the cost to reach the destination address of the route from the ASBR.

The external type-2 routes refer to imported EGP routes. Since these routes have lower credibility, OSPF assumes that the cost from the ASBR to reach the destinations beyond the AS is higher than the cost from within the AS to the ASBR. So in route cost calculation, the cost to reach the external type 2 route equals the cost to the destination address of the route from the ASBR. If the two values are equal, then the cost of the router to the corresponding ASBR is considered.

Perform the following configuration in OSPF view.

Table 43 Configuring OSPF to Import the Routes of Other Protocols

Operation	Command
Enable OSPF to import routes of other protocols	**import-route** *protocol* [**cost** *value* | **type** *value* | **tag** *value* | **route-policy** *route-policy-name*]
Disable importing routing information of other protocols	**undo import-route** *protocol*

By default, OSPF does not import the routing information of other protocols.

The *protocol* variable specifies a source routing protocol that can be imported, such as direct, static, RIP, or BGP.

Configuring Parameters for OSPF to Import External Routes

When OSPF imports the routing information discovered by other routing protocols in the autonomous system, some additional parameters need configuring, such as the default route cost and the default tag of route distribution. Route ID can be used to identify the protocol-related information. For example, OSPF can use it to identify the AS number when receiving BGP.

Perform the following configuration in OSPF view.

Table 44 Configuring Parameters for OSPF to Import External Routes

Operation	Command
Configure the minimum interval for OSPF to import the external routes	**default interval** *seconds*
Restore the default value of the minimum interval for OSPF to import the external routes	**undo default interval**
Configure the upper limit to the routes that OSPF import each time	**default limit** *routes*
Restore the default upper limit to the external routes that can be imported at a time	**undo default limit**
Configure the default cost for the OSPF to import external routes	**default cost** *value*
Restore the default cost for the OSPF to import external routes	**undo default cost**

Table 44 Configuring Parameters for OSPF to Import External Routes

Operation	Command
Configure the default tag for the OSPF to import external routes	**default tag** *tag*
Restore the default tag for the OSPF to import external routes	**undo default tag**
Configure the default type of external routes that OSPF will import	**default type** { **1** | **2** }
Restore the default type of the external routes imported by OSPF	**undo default type**

No default cost and tag are available when importing external routes, and the type of the imported route is type-2. The interval for importing the external route is 1 second. The upper limit to the external routes imported is 1000 per second.

Configuring OSPF to Import the Default Route

The **import-route** command does not import the default route. Using the **default-route-advertise** command, you can import the default route into the routing table.

Perform the following configuration in OSPF view.

Table 45 Configuring OSPF to Import the Default Route

Operation	Command
Import the default route to OSPF	**default-route-advertise** [**always**] [**cost** *value*] [**type** *type-value*] [**route-policy** *route-policy-name*]
Remove the imported default route	**undo default-route-advertise** [**always**] [**cost**] [**type**] [**route-policy**]

By default, OSPF does not import the default route.

Setting OSPF Route Preference

Since it is possible for multiple dynamic routing protocols to run on one router concurrently, there can be the problem of route sharing and selection between routing protocols . The system sets a priority for each routing protocol, which is used in tie-breaking if different protocols discover the same route.

Perform the following configuration in OSPF view.

Table 46 Setting OSPF Route Preference

Operation	Command
Configure a priority for OSPF for comparing with the other routing protocols	**preference** [**ase**] *preference*
Restore the default protocol priority	**undo preference** [**ase**]

By default, the OSPF preference is 10, and the imported external routing protocol is 150.

Configuring OSPF Route Filtering

Perform the following configuration in OSPF view.

Table 47 Enabling OSPF to Filter the Imported Routes

Operation	Command
Enable OSPF filtering of the imported global routing information	**filter-policy {** *acl-number* **| ip-prefix** *ip-prefix-name* **| gateway** *prefix-list- name* **} import**
Disable filtering of the imported global routing information	**undo filter-policy** { *acl-number* | **ip-prefix** *ip-prefix-name* | **gateway** *prefix- list-name* } **import**

By default, OSPF does not filter the imported and distributed routing information.

For a detailed description, see "IP Routing Policy".

Configuring Filling the MTU Field When an Interface Transmits DD Packets

OSPF routers use the DD (Database Description) packets to describe their own LSDs when synchronizing the databases.

By default, the MTU field in DD packets is 0. You can manually specify an interface to fill in the MTU field in a DD packet when it transmits the packet. The MTU should be set to the real MTU on the interface.

Perform the following configuration in VLAN interface view.

Table 48 Configuring Filling MTU Field When an Interface Transmits DD Packets

Operation	Command
Enable an interface to fill in the MTU field when transmitting DD packets	**ospf mtu-enable**
Disable the interface to fill MTU when transmitting DD packets	**undo ospf mtu-enable**

By default, the interface does not fill in the MTU field when transmitting DD packets, and the MTU in the DD packets is 0.

Disabling the Interface to Send OSPF Packets

Use the **silent-interface** command to prevent the interface from transmitting OSPF packets.

Perform the following configuration in OSPF view.

Table 49 Disabling the Interface to Send OSPF Packets

Operation	Command
Prevent the interface from sending OSPF packets	**silent-interface** *silent-interface-type silent-interface-number*
Allow the interface to send OSPF packets	**undo silent-interface** *silent-interface-type silent-interface-number*

By default, all the interfaces are allowed to transmit and receive OSPF packets.

After an OSPF interface is set to silent status, the interface can still advertise its direct route. However, the OSPF calling packets of the interface are blocked, and

no neighboring relationship can be established on the interface. This enhances OSPF's ability to adapt to the network, which reduces the consumption of system resources.

Configuring OSPF and Network Management System (NMS)

Configuring OSPF MIB Binding After multiple OSPF processes are enabled, you can configure to which OSPF process MIB is bound.

Perform the following configuration in system view.

Table 50 Configuring OSPF MIB Binding

Operation	Command
Configure OSPF MIB binding	**ospf mib-binding** *process-id*
Restore the default OSPF MIB binding	**undo ospf mib-binding**

By default, MIB is bound to the first enabled OSPF process.

Configuring OSPF TRAP You can configure the switch to send multiple types of SNMP TRAP packets in case of OSPF anomalies. In addition, you can configure the switch to send SNMP TRAP packets, when a specific process is abnormal, by specifying the process ID.

Perform the following configuration in system view.

Table 51 Enabling/Disabling OSPF TRAP Function

Operation	Command
Enable OSPF TRAP function	**snmp-agent trap enable ospf** [*process-id*] [**ifstatechange** | **virifstatechange** | **nbrstatechange** | **virnbrstatechange** | **ifcfgerror** | **virifcfgerror** | **ifauthfail** | **virifauthfail** | **ifrxbadpkt** | **virifrxbadpkt** | **txretransmit** | **viriftxretransmit** | **originatelsa** | **maxagelsa** | **lsdboverflow** | **lsdbapproachoverflow**]
Disable OSPF TRAP function	**undo snmp-agent trap enable ospf** [*process-id*] [**ifstatechange** | **virifstatechange** | **nbrstatechange** | **virnbrstatechange** | **ifcfgerror** | **virifcfgerror** | **ifauthfail** | **virifauthfail** | **ifrxbadpkt** | **virifrxbadpkt** | **txretransmit** | **viriftxretransmit** | **originatelsa** | **maxagelsa** | **lsdboverflow** | **lsdbapproachoverflow**]

By default, the OSPF TRAP function is disabled so the switch does not send TRAP packets when any OSPF process is abnormal. The configuration is valid for all OSPF processes if you do not specify a process ID.

For detailed configuration of SNMP TRAP, "System Management" on page 301.

Resetting the OSPF Process

If the **undo ospf** command is executed on a router and then the **ospf** command is used to restart the OSPF process, the previous OSPF configuration is lost. With the **reset ospf** command, you can restart the OSPF process without losing the previous OSPF configuration.

Perform the following configuration in user view.

Table 52 Resetting the OSPF Process

Operation	Command
Reset the OSPF process	**reset ospf** [statistics] { all | *process-id* }

Resetting the OSPF process can immediately clear the invalid LSAs, make the modified router ID effective or re-elect the DR and BDR.

Displaying and Debugging OSPF

After configuring OSPF, execute the **display** command in all views to display the operation of the OSPF configuration, and to verify the effect of the configuration. Execute the **debugging** command in user view to debug the OSPF module.

Table 53 Displaying and Debugging OSPF

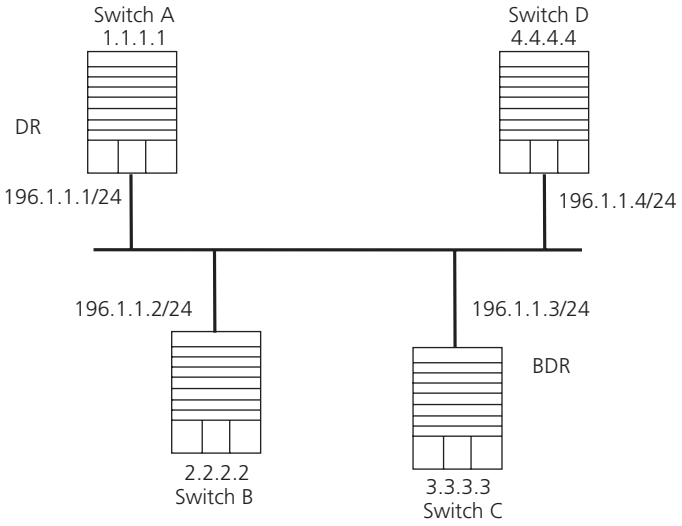
Operation	Command
Display the brief information of the OSPF routing process	**display ospf** [*process-id*] **brief**
Display OSPF statistics	**display ospf** [*process-id*] **cumulative**
Display LSDB information of OSPF	**display ospf** [*process-id*] [*area-id*] **lsdb** [**brief** | [**asbr** | **ase** | **network** | **nssa** | **router** | **summary**] [*ip-address*] [**originate-router** *ip-address* | **self-originate**]]
Display OSPF peer information	**display ospf** [*process-id*] **peer** [**brief**]
Display OSPF next hop information	**display ospf** [*process-id*] **nexthop**
Display OSPF routing table	**display ospf** [*process-id*] **routing**
Display OSPF virtual links	**display ospf** [*process-id*] **vlink**
Display OSPF request list	**display ospf** [*process-id*] **request-queue**
Display OSPF retransmission list	**display ospf** [*process-id*] **retrans-queue**
Display the information of OSPF ABR and ASBR	**display ospf** [*process-id*] **abr-asbr**
Display OSPF interface information	**display ospf** [*process-id*] **interface**
Display OSPF errors	**display ospf** [*process-id*] **error**

Example: OSPF Configuration

Configuring DR Election Based on OSPF Priority

In this example, four Switch 8800 routers, Switch A, Switch B, Switch C, and Switch D, which can perform the router functions and run OSPF, are located on the same segment, as shown in Figure 6.

Figure 6 Configuring DR Election Based on OSPF Priority



The commands listed in the following examples enable Switch A and Switch C to be DR and BDR. The priority of Switch A is 100, which is the highest on the network, so it is elected as the DR. Switch C has the second highest priority, so it is elected as the BDR. The priority of Switch B is 0, which means that it cannot be elected as the DR, and Switch D does not have a priority, which takes 1 by default.

1 Configure Switch A:

```
[Switch A]interface Vlan-interface 1
[Switch A-Vlan-interface1]ip address 196.1.1.1 255.255.255.0
[Switch A-Vlan-interface1]ospf dr-priority 100
[Switch A]router id 1.1.1.1
[Switch A]ospf
[Switch A-ospf-1]area 0
[Switch A-ospf-1-area-0.0.0.0]network 196.1.1.0 0.0.0.255
```

2 Configure Switch B:

```
[Switch B]interface Vlan-interface 1
[Switch B-Vlan-interface1]ip address 196.1.1.2 255.255.255.0
[Switch B-Vlan-interface1]ospf dr-priority 0
[Switch B]router id 2.2.2.2
[Switch B]ospf
[Switch B-ospf-1]area 0
[Switch B-ospf-1-area-0.0.0.0]network 196.1.1.0 0.0.0.255
```

3 Configure Switch C:

```
[Switch C]interface Vlan-interface 1
[Switch C-Vlan-interface1]ip address 196.1.1.3 255.255.255.0
[Switch C-Vlan-interface1]ospf dr-priority 2
[Switch C]router id 3.3.3.3
[Switch C]ospf
[Switch C-ospf-1]area 0
[Switch C-ospf-1-area-0.0.0.0]network 196.1.1.0 0.0.0.255
```

4 Configure Switch D:

```
[Switch D]interface Vlan-interface 1
[Switch D-Vlan-interface1]ip address 196.1.1.4 255.255.255.0
[Switch D]router id 4.4.4.4
```

```
[Switch D]ospf
[Switch D-ospf-1]area 0
[Switch D-ospf-1-area-0.0.0.0]network 196.1.1.0 0.0.0.255
```

On Switch A, execute the **display ospf peer** command to display the OSPF neighbors. Note that Switch A has three neighbors.

The state of each neighbor is full, which means that adjacency is set up between Switch A and each neighbor. Switch A and Switch C should set up adjacencies with all the routers on the network so that they can serve as the DR and BDR on the network. Switch A is DR, while Switch C is BDR on the network, and all the other neighbors are DR others (which means that they are neither DRs nor BDRs).

5 Modify the priority of Switch B to 200:

```
[Switch B-Vlan-interface2000]ospf dr-priority 200
```

In Switch A, execute the **display ospf peer** command to show its OSPF neighbors. Note that the priority of Switch B has been modified to 200, but it is still not the DR.

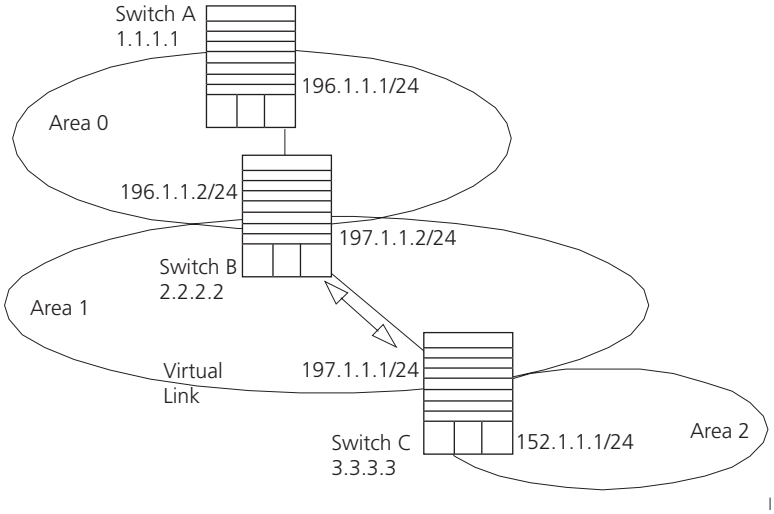
Only when the current DR is offline, does the DR change. Shut down Switch A, and run the **display ospf peer** command on Switch D to display its neighbors. Note that the original BDR (Switch C) becomes the DR, and Switch B is the BDR now.

If all switches on the network are removed and added again, Switch B is elected as the DR (with the priority of 200), and Switch A becomes the BDR (with a priority of 100). To switch off and restart all the switches initiates a new round of DR and BDR selection.

Configuring OSPF Virtual Links

In Figure 7, Area 2 and Area 0 are not directly connected. Area 1 is used as the transit area for connecting Area 2 and Area 0.

Figure 7 OSPF Virtual Link Configuration



The commands listed below implement this configuration.

1 Configure Switch A:

```
[Switch A]interface Vlan-interface 1
```

```
[Switch A-Vlan-interface1]ip address 196.1.1.1 255.255.255.0
[Switch A]router id 1.1.1.1
[Switch A]ospf
[Switch A-ospf]area 0
[Switch A-ospf-area-0.0.0.0]network 196.1.1.0 0.0.0.255
```

2 Configure Switch B:

```
[Switch B]interface vlan-interface 7
[Switch B-Vlan-interface7]ip address 196.1.1.2 255.255.255.0
[Switch B]interface vlan-interface 8
[Switch B-Vlan-interface8]ip address 197.1.1.2 255.255.255.0
[Switch B]router id 2.2.2.2
[Switch B]ospf
[Switch B-ospf]area 0
[Switch B-ospf-area-0.0.0.0]network 196.1.1.0 0.0.0.255
[Switch B-ospf-area-0.0.0.0]quit
[Switch B-ospf]area 1
[Switch B-ospf-area-0.0.0.1]network 197.1.1.0 0.0.0.255
[Switch B-ospf-area-0.0.0.1]vlink-peer 3.3.3.3
```

3 Configure Switch C:

```
[Switch C]interface Vlan-interface 1
[Switch C-Vlan-interface1]ip address 152.1.1.1 255.255.255.0
[Switch C]interface Vlan-interface 1
[Switch C-Vlan-interface1]ip address 152.1.1.1 255.255.255.0
[Switch C]interface Vlan-interface 2
[Switch C-Vlan-interface2]ip address 197.1.1.1 255.255.255.0
[Switch C]router id 3.3.3.3
[Switch C]ospf
[Switch C-ospf]area 1
[Switch C-ospf-area-0.0.0.1]network 197.1.1.0 0.0.0.255
[Switch C-ospf-area-0.0.0.1]vlink-peer 2.2.2.2
[Switch C-ospf-area-0.0.0.1]quit
[Switch C-ospf]area 2
[Switch C-ospf-area-0.0.0.2]network 152.1.1.0 0.0.0.255
```

Troubleshooting OSPF

1 OSPF has been configured according to the previous procedures, but OSPF on the router does not run normally.

- Troubleshoot locally

  Check whether the protocol between two directly connected routers is operating normally. The normal sign is the peer state machine between the two routers reaches the "FULL" state. Note that on a broadcast or NBMA network, if the interfaces for two routers are in the DROther state, the peer state machine for the two routers is in the 2-way state, instead of the FULL state. The peer state machine between the DR or BDR, and all the other routers is in the FULL state.

  - Execute the **display ospf peer** command to view peers.
  - Execute the **display ospf interface** command to view OSPF information in the interface.
  - Execute the **ping** command to test whether the physical connections and the lower level protocol operate normally. If the local router cannot ping the

peer router, it indicates that faults have occurred to the physical link and the lower level protocol.

- If the physical link and the lower layer protocol are normal, check the OSPF parameters configured on the interface. The parameters should be the same parameters configured on the router adjacent to the interface. The same area ID should be used, and the networks and the masks should also be consistent. (The P2P or virtually linked segment can have different segments and masks.)
- Insure that the dead timer on the same interface is at least four times the value of the hello timer.
- If the network type is NBMA, the peer must be manually specified, using the **peer ip-address** command.
- If the network type is broadcast or NBMA, there must be at least one interface with a priority greater than zero.
- If an area is set as the STUB area to which the routers are connected, the area on these routers must also be set as a STUB area.
- The same interface type should be adopted for the neighboring routers.
- If more than two areas are configured, at least one area should be configured as the backbone area with an area ID of 0.
- Ensure that the backbone area connects with all other areas.
- The virtual links cannot pass through the STUB area.

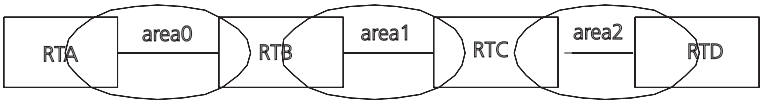
- Troubleshooting globally

  If OSPF cannot discover remote routes and OSPF has been configured according to the previous procedures, and you have checked all local troubleshooting items, verify the following configurations.

  - If more than two areas are configured on a router; at least one area should be configured as the backbone area.

    As shown in Figure 8, RTA and RTD are each configured to belong to only one area, whereas RTB and RTC are both configured to belong to two areas. RTB belongs to area0, which complies with the backbone area membership requirement. However, RTC does not belong to area0. Therefore, a virtual link must be set up between RTC and RTB to insure that area2 and area0 (the backbone area) are connected.

Figure 8 OSPF Areas



  - The backbone area (area0) cannot be configured as the STUB area and the virtual link cannot pass through the STUB area. So, if a virtual link has been set up between RTB and RTC, neither area1 nor area0 can be configured as a STUB area. Only area2 can be configured as a STUB area.
  - Routers in the STUB area cannot redistribute the external routes.

IS-IS

Intermediate System-to-Intermediate System (IS-IS) intra-domain routing information exchange protocol is the dynamic routing protocol used in the AS issued by the International Organization for Standardization (ISO). An intermediate system (IS) in the OSI reference model is basically equivalent to a router in the TCP/IP reference model. The IS-IS protocol, based on the link state algorithm, uses the Shortest Path First (SPF) algorithm. It is similar to the Open Shortest Path First (OSPF) protocol.

Integrated IS-IS is an implementation of IS-IS for IP regulated by the IETF.

This section introduces IS-IS routing protocol terms.

- Intermediate System (IS). An IS equals a router of TCP/IP. It is the basic unit in the IS-IS protocol used for propagating routing information and generating routes. In the following text, *IS* is equal to *router.*
- End System (ES). An ES equals the host system of TCP/IP. An ES does not process the IS-IS routing protocol, and therefore it can be ignored in the IS-IS protocol.
- Routing Domain (RD). A group of ISs exchange routing information with the same routing protocol in a routing domain.
- Area. Area is the division unit in the routing domain.
- Link State DataBase (LSDB). All the link states in the network form the LSDB. In an IS, at least one LSDB is available. The IS uses the SPF algorithm and the LSDB to generate its own routes.
- Link State Protocol Data Unit (LSP). In the IS-IS, each IS will generate an LSP which contains all the link state information of the IS. Each IS collects all the LSPs in the local area to generate its own LSDB.
- Network Protocol Data Unit (NPDU). NPDUs are the network layer packets of ISO and are basically equivalent to the IP packet of TCP/IP.
- Designated Intermediate System (DIS), is the elected router on the broadcast network, equivalent to the DR in OSPF.
- Network Service Access Point (NSAP) is the ISO network layer address. It identifies an abstract network service access point and describes the network address for ISO model routing.

Configuring IS-IS is described in the following sections:

- Two-Level Structure of IS-IS
- NSAP Structure of IS-IS
- IS-IS Packets
- Configuring Integrated IS-IS
- Integrated IS-IS Configuration Example

Two-Level Structure of IS-IS

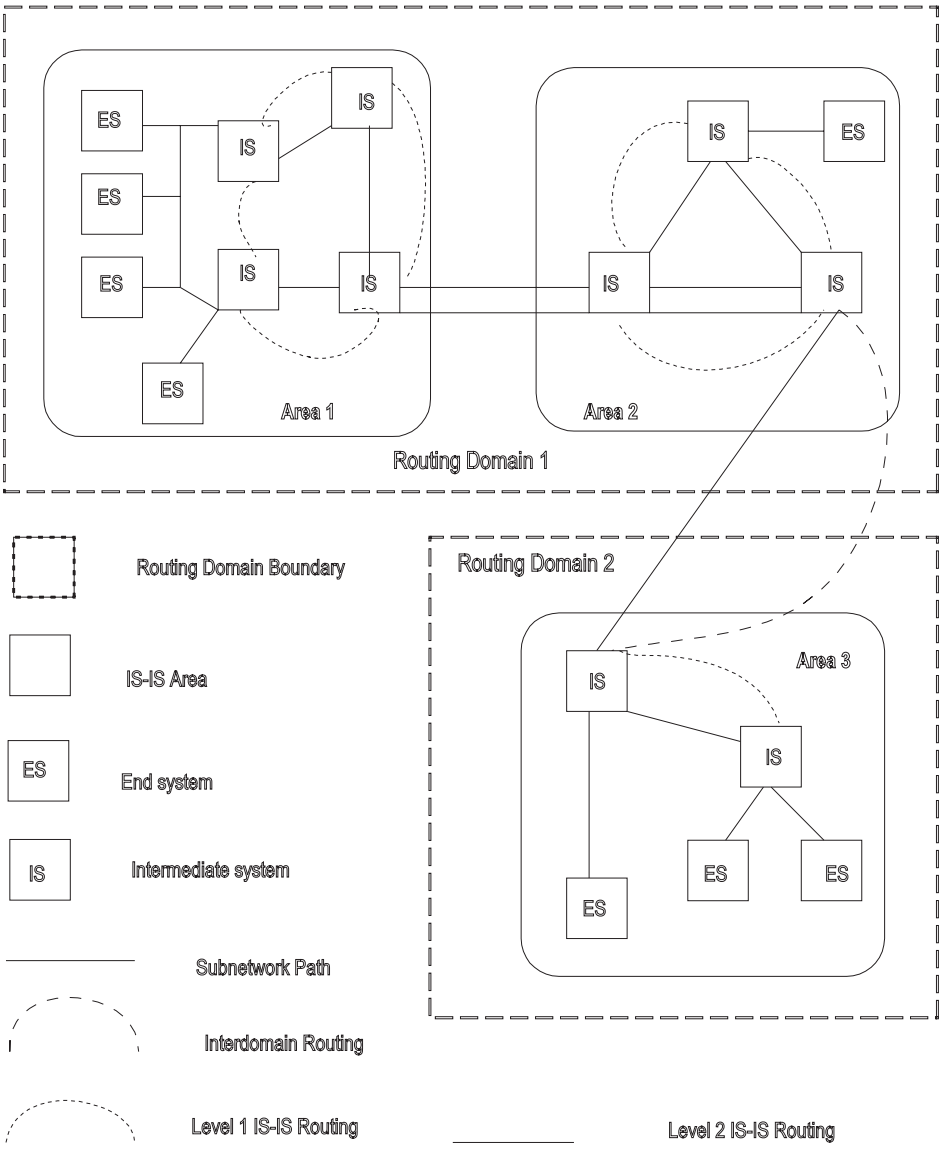
IS-IS adopts a two-level structure, Level-1 and Level-2, in a routing domain (or an AS) to support a large-scale routing network. A large RD is divided into one or more areas. The Level-1 routers manage the intra-area routing and are responsible for communicating with other Level-1 routers in the same area. The Level-2 routers manage the inter-area routing.

All the Level-2 routers make up the backbone network of the RD, which is responsible for the inter-area communications. Every area has at least one router located on both Level-1 and Level-2 (called a Level-1/Level-2 router), which connects the area to the backbone network. A Level-1/Level-2 router contiguous with a router in some other area will notify the Level-1 routers in the local area that it is an exit point from the area.

For an NPDU to go from its own area to another area, a Level-1 router will first transmit it to the nearest Level-1/Level-2 router in the local area, regardless of its actual destination area. Then, the NPDU will be transmitted over the Level-2 backbone network to a Level-1 router in the destination area. Finally the Level-1 router transmits the NPDU to the destination.

Figure 9 illustrates a network running the IS-IS routing protocol and composed of two RDs, Routing Domain 1 and Routing Domain 2. Routing Domain 1 includes two areas, Area 1 and Area 2, and Routing Domain 2 only has Area 3. In Routing Domain 1, the three ISs connected by bold lines compose the area backbone. They are all Level-1/Level-2 routers. The other 4 ISs not connected by bold line are Level-1 routers.

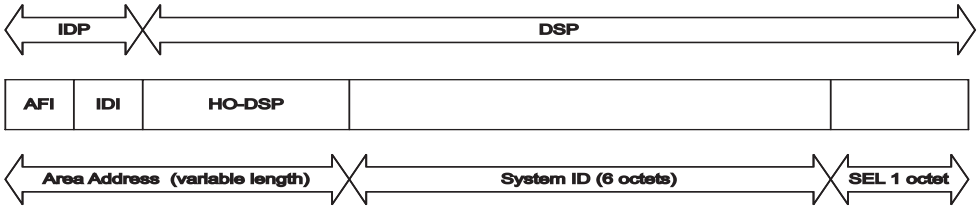
Figure 9 IS-IS Topology



NSAP Structure of IS-IS

Figure 10 illustrates the NSAP structure. The whole address is of 8 to 20 bytes long.

Figure 10 NSAP Structure



NSAP includes initial domain part (IDP) and domain specific part (DSP). IDP and DSP are length-variable with a total length of 20 bytes. The IDP is composed of the

authority and format identifier (AFI) and initial domain identifier (IDI). The AFI defines the format of the IDI. The DSP has several bytes.

The Area Address is composed of routing field and area identifier. The routing field includes the AFI and the IDI and may also include the first byte of the DSP. It identifies the organizational structure. It is followed by a 16-bit area identifier.

The following 48 bits (or 6 bytes) of System ID identifies the host or router uniquely. A router that belongs to different areas has only one identifier.

NSAP Selector (SEL) of 8 bits does not select routes but equals the protocol identifier of IP. Different transmission protocols correspond to different identifiers. All the SELs of IP are 00.

AFI+IDI+HO-DSP+System ID+SEL composes the Network Entity Title, or NET for short, which indicates the area address and system ID for routing. The ID should be unique inside the whole area and on the backbone (Level-2).

For example, there is a NET 47.0001.aaaa.bbbb.cccc.00, in which,

Area=47.0001, System ID=aaaa.bbbb.cccc, SEL=00.

For example, there is a NET 01.1111.2222.4444.00, in which,

Area=01, System ID=1111.2222.4444, and SEL=00.

IS-IS Packets

IS-IS packets are directly encapsulated in the data link frames and mainly divided into 4 kinds, IIH, LSP, CSNP, and PSNP.

- Intermediate System to Intermediate System Hello PDU (IIH). This packet is transmitted regularly to detect whether a contiguous system is running IS-IS This supports establishing adjacency and allows data to be propagated in Link State Protocol Data Units (LSPs).
- Link State Protocol Data Unit (LSP). This packet is used for propagating link state records throughout the area. LSPs includes Level-1 LSPs and Level-2 LSPs. Level-2 LSPs contain information about all reachable areas. Level-1 LSPs are only used for the local area.
- Complete Sequence Numbers Protocol Data Unit (CSNP). CSNP includes Level-1 CSNP and Level-2 CSNP. The CSNP is used for database synchronization. The DIS transmits to CSNPs (every 10 seconds by default) regularly on the broadcast network. Over the p2p serial line, the CSNP is transmitted only when the adjacent relationship is established for the first time.
- Partial Sequence Numbers Protocol Data Unit (PSNP). PSNP includes Level-1 PSNPs and Level-2 PSNPs. The PSNP supports the database synchronization. Over the p2p link, the routers transmit PSNP as Ack response to acknowledge the receipt of a certain LSPs. Also, if a router finds, from the received CSNP, that it is missing some data (or the original database is older), it will transmit a PSNP requesting a new LSP.

For more information, refer to relevant documentation, such as ISO 10589.

Configuring Integrated IS-IS

Integrated IS-IS is designed to function as a routing protocol for IP. Therefore, the network must be set up with IP addresses and VLANs in the same way that is required for RIP or OSPF. This set up is not discussed in this section.

Beyond the standard IP setup, you must decide what type of routing hierarchy to implement. For example, should all routers be set up as level-2 or level-1 routers or should a level- 2 backbone be constructed connecting various level-1 areas?

Regardless of your decision, the following configuration tasks are required for IS-IS to function as a routing protocol:

- Enabling IS-IS globally
- Setting up the desired VLANs and IP interfaces
- Setting the network entity title
- Enabling IS-IS on the required interfaces

Beyond these required commands, the following configuration tasks are common:

- Setting the router type and level, and the interface level based on the routing hierarchy you select
- Setting the cost of an interface to optimize routing decisions
- Setting authentication at the interface, area, or domain level using simple password or MD5 authentication
- Setting default route generation
- Importing routes from, or exporting routes to, other protocols. To export to a protocol, see the section that discusses that protocol.

All of these commands are discussed in this section. This section also describes other commands that are used less frequently. For example, most users should not change the default values of the various protocol timers, nor do they need to change the SPF calculation parameters. Other commands described may be used under specific network conditions (large number of routes, highly meshed designs) to either optimize or troubleshoot IS-IS.

IS-IS configuration tasks are discussed in the following sections:

- Enabling IS-IS and Entering the IS-IS View
- Setting the Network Entity Title (NET)
- Enabling IS-IS on the Specified Interface
- Configuring IS-IS Route Metric Type
- Setting IS-IS Link State Routing Cost
- Setting the Hello Packet Broadcast Interval
- Setting the CSNP Packet Broadcast Interval
- Setting the LSP Packet Interval
- Setting the LSP Packet Retransmission Interval
- Setting the Hello Failure Interval
- Setting the Priority for DIS Election
- Setting the Interface Circuit Level

- Setting IS-IS Authentication
- Setting the Mesh Group of the Interface
- Setting the Router Type
- Setting Default Route Generation
- Setting a Summary Route
- Setting the Overload Flag Bit
- Setting to Ignore the LSP Checksum Errors
- Setting Peer Change Logging
- Setting the LSP Refresh Interval
- Setting the Lifetime of LSP
- Setting the SPF Calculation in Slice
- Setting SPF to Release CPU Resources
- Setting the SPF Computing Interval
- Enabling or Disabling the Interface to Send Packets
- Configuring IS-IS to Import Routes of Other Protocols
- Configuring IS-IS Route Filtering
- Setting the Preference of the IS-IS Protocol
- Resetting All the IS-IS Data Structures
- Resetting the Specified IS-IS Peer
- Displaying and Debugging IS-IS

Enabling IS-IS and Entering the IS-IS View

To run the IS-IS protocol, you need to create an IS-IS routing process.

After creating an IS-IS routing process in system view, you should also set the Network Entity Title (NET) and activate this routing process at an interface that may be adjacent to another router. After that, the IS-IS protocol can be started and run.

Perform the following configuration in system view.

Table 54 Enabling IS-IS and Entering the IS-IS View

Operation	Command
Enable IS-IS and enter the IS-IS view	**isis** [*tag*]
Cancel the specified IS-IS routing process	**undo isis** [*tag*]

The *tag* parameter identifies the IS-IS process. In the present version, just one IS-IS process is allowed.

By default, the IS-IS routing process is disabled.

Setting the Network Entity Title (NET)

Network Entity Titles (hereafter referred to as NETs) define the current IS-IS area addresses and the system ID of the router.

Perform the following configuration in IS-IS view.

Table 55 Setting the Network Entity Title (NET)

Operation	Command
Set Network Entity Title (NET)	**network-entity** *net*
Delete a NET	**undo network-entity** *net*

The format of parameter *net* is X…X.XXXXXXXXXXXX.XX, among which the first "X…X" is the area address, the twelve Xs in the middle is the System ID of the router. The last XX should be 00.

CAUTION: *A router can be configured with multiple area addresses. However, the routers in the same area should be configured with the same area address. Every router must have a unique System ID.*

Enabling IS-IS on the Specified Interface

After enabling IS-IS, you must specify on which interfaces IS-IS will run.

Perform the following configurations in VLAN interface view.

Table 56 Enabling IS-IS on the Specified Interface

Operation	Command
Enable IS-IS on the specified Interface	**isis enable** [*tag*]
Cancel this designation	**undo isis enable** [*tag*]

Configuring IS-IS Route Metric Type

IS-IS routing protocol has two styles of route metrics:

- **Narrow:** the value of route metric ranges from 1 to 63.
- **Wide:** the value of route metric ranges from 1 to 16777215.

The switch can choose either or both of the styles.

Perform the following configuration in IS-IS view.

Table 57 Configuring the Style for Route Metric Values of IS-IS Packets

Operation	Command
Configure the style for route metric values of IS-IS packets	**cost-style** { **narrow** | **wide** | **wide-compatible** | { **compatible** | **narrow-compatible** } [**relax-spf-limit**] }
Restore the default settings	**undo cost-style**

By default, IS-IS only receives and sends the packets whose route metric is in narrow style.

Setting IS-IS Link State Routing Cost

Users can configure the interface (default routing) cost.

Perform the following configuration in VLAN interface view..

Table 58 Setting IS-IS Link State Routing Cost

Operation	Command
Set the routing cost of the interface	**isis cost** *value* [**level-1** | **level-2**]
Restore the default routing cost of the interface	**undo isis cost** [**level-1** | **level-2**]

If the level is not specified, the default setting is, Level-1 routing cost.

The *value* parameter is configured according to the link state of the Interface.

By default, the routing cost of IS-IS on an interface is 10.

Setting the Hello Packet Broadcast Interval

The IS-IS periodically sends Hello packets from the Interface, and the routers maintain adjacency through the transmission and receipt of Hello packets The Hello packet interval can be modified.

Usually, on broadcast links, there exist level-1 and level-2 hello packets. If you want a different hello interval for Level-1 and Level-2, you must set the intervals separately. However, there are two exceptions. One exception is when there is no level separation in the link, parameters of level-1 and level-2 need not be specified in the command.

The other exception is that attributes of the packets do not need to be set if hello packets are not separated according to level-1 and level-2 on the **p2p** links.

Perform the following configurations in VLAN interface view..

Table 59 Setting the Hello Packet Broadcast Interval

Operation	Command
Set Hello packet interval, measured in seconds.	**isis timer hello** *seconds* [**level-1** | **level-2**]
Restore the default Hello packet interval on the interface	**undo isis timer hello** [**level-1** | **level-2**]

By default, Hello packets are transmitted on an interface every 10 seconds.

Setting the CSNP Packet Broadcast Interval

The CSNP packet is transmitted by the DIS over the broadcast network to synchronize the link state database (LSDB). The CSNP packet is regularly broadcast over the broadcast network at an interval, which can be set by users.

Perform the following configuration in VLAN interface view.

Table 60 Setting the CSNP Packet Broadcast Interval

Operation	Command
Set the CSNP packet broadcast interval, measured in seconds	**isis timer csnp** *seconds* [**level-1** | **level-2**]
Restore the default CSNP packet broadcast interval on the interface	**undo isis timer csnp** [**level-1** | **level-2**]

If the level is not specified, it defaults to setting the CSNP packet broadcast interval for Level-1.

By default, the CSNP packet is transmitted by an interface every 10 seconds.

Setting the LSP Packet Interval

LSP carries the link state records for propagation throughout the area.

Perform the following configuration in VLAN interface view..

Table 61 Setting the LSP Packet Interval

Operation	Command
Set LSP packet interval on the interface, measured in milliseconds.	**isis timer lsp** *time*
Restore the default LSP packet interval on the interface	**undo isis timer lsp**

By default, the minimum time between the consecutive transmissions of 2 LSPs is 33 milliseconds.

Setting the LSP Packet Retransmission Interval

If the local end does not receive a response within a period of time after it sends an LSP packet over a **p2p** link, it assumes that the LSP packet has been lost or dropped. To guarantee transmission reliability, the local router will retransmit the original LSP packet.

Perform the following configurations in VLAN interface view..

Table 62 Setting LSP Packet Retransmission Interval

Operation	Command
Set the retransmission interval of the LSP packet over **p2p** links	**isis timer retransmit** *seconds*
Restore the default retransmission interval of the LSP packet over **p2p** links	**undo isis timer retransmit**

By default, the LSP packet is transmitted every 5 seconds over the **p2p** link.

Setting the Hello Failure Interval

The IS-IS protocol maintains adjacency between routers by transmitting and receiving Hello packets. If the local router does not continuously receive Hello packets within the time interval transmitted by the peer, it considers the adjacent router to be down.

Perform the following configurations in VLAN interface view..

Table 63 Setting the Hello Failure Interval on the Interface

Operation	Command
Set the Hello failure interval on the interface	**isis timer dead** *seconds* [**level-1** | **level-2**]
Restore the default Hello failure interval on the interface	**undo isis timer dead** [**level-1** | **level-2**]

By default, the Hello failure interval is 30 seconds. If the level is not specified, it defaults to setting the Hello packet failure interval Level-1.

Setting the Priority for DIS Election

In the broadcast network, the IS-IS needs to elect a DIS from all the routers.

In IS-IS, both a Level-1 and a Level-2 DIS are selected, based on priority. An IS/router with a higher priority will be selected as DIS over a router with a lower priority. If there are two or more routers with the highest priority in the broadcast network, the one with the greatest MAC address will be selected. If all the adjacent routers' priorities are 0, the one with the greatest MAC address will be selected.

The DISs of Level-1 and Level-2 are elected separately. You can set different priorities for DIS election at different levels.

Perform the following configuration in VLAN interface view..

Table 64 Setting Priority for DIS Election

Operation	Command
Set the priorities for DIS election on the interface	**isis dis-priority** *value* [**level-1** | **level-2**]
Restore the default priorities for DIS election on the interface	**undo isis dis-priority** [**level-1** | **level-2**]

By default, the interface priority is 64. If the level is not specified, it defaults to the priority of Level-1.

Setting the Interface Circuit Level

Perform the following configuration in VLAN interface view..

Table 65 Setting the Interface Circuit Level

Operation	Command
Set the interface circuit level	**isis circuit-level** [**level-1** | **level-1-2** | **level-2**]
Restore the default interface circuit level	**undo isis circuit-level**

You can set the circuit level to limit what type of adjacency can be established for the interface. For example, a Level-1 interface can only establish a Level-1 adjacency. A Level-2 interface can only establish a Level-2 adjacency. For the Level-1-2 router, you can configure some interfaces as Level-2 to prevent transmitting Level-1 Hello packets on the Level-2 backbone and conserve bandwidth. However Level-1 and Level-2 use the same kind of Hello packet over the **p2p** link, and therefore such a setting is unnecessary.

By default, the circuit-level on an interface is **level-1-2**.

Setting IS-IS Authentication

Setting IS-IS authentication involves tasks described in the following three sections.

Setting Interface Authentication The authentication password set on the interface is mainly used in the Hello packet to confirm the validity and correctness of its peers. The authentication passwords at the same level for all the connected interfaces of a network should be identical.

Perform the following configurations in VLAN interface view..

Table 66 Setting the Interface Authentication Password

Operation	Command
Set the authentication password	**isis authentication-mode** { **simple** | **md5** } *password* [{ **level-1** | **level-2** } [**ip** | **osi**]]
Delete the authentication-mode password	**undo isis authentication-mode** { **simple** | **md5** } *password* [{ **level-1** | **level-2** } [**ip** | **osi**]]

By default, the interface is not configured with any authentication password and does not perform authentication. If the level is not specified when you set authentication, it defaults to set the authentication password of Level-1.

IP or OSI authentication mode is not related to whether IP or OSI CLNP packet forwarding is used. OSI authentication mode is most common.

Setting the IS-IS Area or IS-IS Routing Domain Authentication Password

Users can configure the IS-IS area or the IS-IS routing domain with an authentication password.

If area authentication is needed, the area authentication password will be encapsulated into the level-1 LSP, CSNP and PSNP packets, using the specified mode (md5 or simple text). All routers in the same area must have identical passwords and authentication modes to work together correctly. Similarly, for domain authentication, the password will be encapsulated into the level-2 LSP, CSNP and PSNP packets using the specified mode. If the routers in the backbone layer (level-2) need domain authentication, the authentication mode and password must be identical on all.

The passwords for authentication of the routers on the same network segment must be identical.

Perform the following configurations in IS-IS view.

Table 67 Setting IS-IS Authentication Password

Operation	Command
Set authentication-mode password	**area-authentication-mode** { **simple** | **md5** } *password* [**ip** | **osi**]
Delete authentication-mode password	**undo area-authentication-mode** { **simple** | **md5** } [**ip** | **osi**]
Set routing domain authentication password	**domain-authentication-mode** { **simple** | **md5** } *password* [**ip** | **osi**]
Delete routing domain authentication password	**undo domain-authentication-mode** { **simple** | **md5** } [**ip** | **osi**]

By default, the system does not require passwords or perform authentication.

Setting the IS-IS to Use the MD5 Algorithm That Is Compatible With Other Vendors' You must configure this command when the switch needs to authenticate the devices of other vendors using MD5 algorithm in IS-IS.

Perform the following configurations in IS-IS view.

Table 68 Set IS-IS to use the MD5 Algorithm that is Compatible With Other Vendors'

Operation	Command
Set the IS-IS to use the MD5 algorithm that is compatible with the algorithm of another vendor	**md5-compatible**
Set the IS-IS to use the default MD5 algorithm	**undo md5-compatible**

By default, the system uses the MD5 algorithm in IS-IS that is compatible with the 3Com algorithm.

Setting the Mesh Group of the Interface

On NBMA network, the interface of a router will flood the received LSP to other interfaces. However, this processing method applied to a network with higher connectivity and several p2p links will cause repeated LSP flooding and waste bandwidth.

To avoid this problem, you can configure several interfaces into a mesh group. The interface will flood outside the group only.

Perform the following configurations in VLAN interface view..

Table 69 Setting the Mesh Group of the Interface

Operation	Command
Add an interface to a mesh group.	**isis mesh-group** { mesh-group-number | **mesh-blocked** }
Remove the interface from the mesh group	**undo isis mesh-group**

By default, the LSP is flooded normally from the interface. When configured with the **mesh-blocked** parameter, it will not flood the LSP to other interfaces.

The IS-IS configuration tasks on the interface are finished. The following sections discuss how to configure other parameters of IS-IS.

Setting the Router Type

Users can set the level for the current router; based upon the location of the router in the network, Level-1 (intra-domain router), Level-2 (inter-domain router) and Level-1-2 (intra-domain router as well as inter-domain router) can be selected.

Perform the following configurations in IS-IS view..

Table 70 Setting the Router Type

Operation	Command
Set router type	**is-level** { **level-1** | **level-1-2** | **level-2** }
Restore the default router type	**undo is-level**

By default, the router type is **level-1-2**.

Setting Default Route Generation

In an IS-IS route domain, a Level-1 router only has the LSDB for the local area, so it can only generate routes for the local areas. The Level-2 router has the backbone LSDB for the IS-IS route domain and generates backbone network routes only. If a Level-1 router in one area wants to forward packets to other areas, it must first forward the packets to the closest Level-1-2 router in the local area according to its default route.

Perform the following configurations in IS-IS view..

Table 71 Setting Default Route Generation

Operation	Command
Set to generate default route	**default-route-advertise** [**route-policy** *route-policy-name*]
Set not to generate default route	**undo default-route-advertise** [**route-policy** *route-policy-name*]

The default route generated by this command will only be propagated to routers at the same level.

By default, a Level-1-2 router will set its attach bit if it is connected to the backbone. This creates a default route out of the attached Level-1 area. Additional default routes (from the Level-2 backbone to another AS, for example) can be set using this command and route policy.

Setting a Summary Route

You can aggregate several different routes. This converts the advertisement processes of several routes into the advertisement of a single route and simplifies the routing table.

Perform the following configurations in IS-IS view..

Table 72 Setting a Summary Route

Operation	Command
Set summary route	**summary** *ip-address ip-mask* [**level-1** | **level-1-2** | **level-2**]
Delete the summary route	**undo summary** *ip-address ip-mask* [**level-1** | **level-1-2** | **level-2**]

By default, routing summarization is disabled.

Setting the Overload Flag Bit

Sometimes, router in the IS-IS domain may encounter operational problems that can affect the entire routing area.

In order to avoid this problem, we can set the overload flag bit for this router.

When the overload threshold is set on a router, other routers should not send packets for this router to forward. However, other routers can still forward packets to be delivered to network segments that are directly attached to the router.

Perform the following configurations in IS-IS view.

Table 73 Setting Overload Flag Bit

Operation	Command
Set overload flag bit	**set-overload**
Remove the overload flag bit	**undo set-overload**

By default, no overload bit is set.

Setting to Ignore the LSP Checksum Errors

After receiving an LSP packet, the local IS-IS calculates its checksum and compares the result with the checksum in the LSP packet. By default, if the checksum in the packet is found to be inconsistent with the calculated result, the LSP is processed and rejected. In networks that are prone to corruption, this could result in a packet corruption storm. However, if the **ignore-lsp-checksum-error** command is executed, the LSP will be discarded silently when a checksum error is found .

Perform the following configurations in IS-IS view..

Table 74 Setting to Ignore the LSP Checksum Errors

Operation	Command
Discard the LSPs with checksum errors	**ignore-lsp-checksum-error**
Set not to discard the LSP checksum errors	**undo ignore-lsp-checksum-error**

By default, LSP checksum errors are not ignored.

Setting Peer Change Logging

After peer change logging is enabled, IS-IS peer changes will be output on the configuration terminal until logging is disabled.

Perform the following configuration in IS-IS view..

Table 75 Setting to Log the Peer Changes

Operation	Command
Enable peer changes log	**log-peer-change**
Disable peer changes log	**undo log-peer-change**

By default, the peer change logging is disabled.

Setting the LSP Refresh Interval

In order to ensure that the LSPs in the whole area can maintain synchronization, all current LSPs will be transmitted periodically.

Perform the following configurations in IS-IS view.

Table 76 Setting LSP Refresh Interval

Operation	Command
Set LSP refresh interval	**timer lsp-refresh** *seconds*
Restore the default LSP refresh interval	**undo timer lsp-refresh**

By default, an LSP is refreshed every 900 seconds (15 minutes).

Setting the Lifetime of LSP

When a router generates an LSP, it sets the maximum lifetime of the LSP. When other routers receive this LSP, they reduce its lifetime continuously as time passes. If an updated LSP has not been received before the old one times out, the LSP is deleted from the LSDB.

Perform the following configurations in IS-IS view..

Table 77 Setting Lifetime of LSP

Operation	Command
Set lifetime of LSP	**timer lsp-max-age** *seconds*
Restore the default LSP lifetime	**undo timer lsp-max-age**

By default, an LSP pages out after 1200 seconds (20 minutes).

Setting the SPF Calculation in Slice

When there are a large number of routes in the routing table (over 150,000), the IS-IS SPF calculation can occupy system resources for an extended time. To prevent this, the SPF calculation can be set to execute in slices.

Perform the following configuration in IS-IS view.

Table 78 Setting SPF Calculation in Slice

Operation	Command
Set the duration of one cycle for SPF calculation	**spf-slice-size** *seconds*
Restore the default configuration	**undo spf-slice-size**

By default, the SPF calculation is not divided into slices but runs to completion. This can also be implemented by setting the parameter *seconds* to 0.

After slice calculation is set, the routes that are not processed at once will be calculated after one second.

Normally, you should not modify the default configuration. When the number of routes is between 150,000 and 200,000, you should set the parameter *seconds* to 1, that is, the duration time for SPF calculation each time is 1 second.

Setting SPF to Release CPU Resources

To prevent SPF calculation from occupying the system resources for a long time, which impacts the response speed of the console, SPF can be set to automatically release the system CPU resources after processing a certain number of routes. The unprocessed routes will be calculated after one second.

Perform the following configurations in IS-IS view..

Table 79 Setting SPF to Release CPU Resources

Operation	Command
Set the number of routes to process before releasing the CPU	**spf-delay-interval** *number*
Restore the default configuration	**undo spf-delay-interval**

By default, the CPU is released after 5000 routes are processed by the SPF of IS-IS.

Setting the SPF Computing Interval

When the IS-IS LSDB changes, the router will compute the shortest path again. However, an immediate calculation upon every change will occupy too many resources and affect the efficiency of the router. If the SPF computing interval is set, and the LSDB changes, the SPF algorithm will be run after the SPF interval times out.

Perform the following configurations in IS-IS view..

Table 80 Setting SPF Computing Interval

Operation	Command
Set SPF computing interval	**timer spf** *second* [**level-1** | **level-2**]
Restore default SPF computing interval	**undo timer spf** [**level-1** | **level-2**]

If the level is not specified, it defaults to setting the SPF computing interval for Level-1.

By default, the SPF calculation runs every 5 seconds.

Enabling or Disabling the Interface to Send Packets

Use the **silent-interface** command to prevent an interface from sending IS-IS routing information to a router in a network.

Perform the following configurations in IS-IS view..

Table 81 Enabling/Disabling the Interface to Send IS-IS Packets

Operation	Command
Prevent the interface from sending IS-IS packets	**silent-interface** *silent-interface-type silent-interface-number*
Allow the interface to send IS-IS packets	**undo silent-interface** *silent-interface-type silent-interface-number*

By default, the interface is allowed to receive and send IS-IS packets.

The **silent-interface** command is only used to prevent the IS-IS packets from being sent on the interface, but interface routes can still be sent from other interfaces.

Configuring IS-IS to Import Routes of Other Protocols

For IS-IS, the routes discovered by other routing protocols are processed as routes outside the routing domain. When importing the routes of other protocols, you can specify their default cost.

When IS-IS imports routes, you can also specify whether to import the routes into Level-1, Level-2 or Level-1-2.

Perform the following configurations in IS-IS view..

Table 82 Importing Routes of Other Protocols

Operation	Command
Import routes of other protocols	**import-route** *protocol* [**cost** *value* | **type** { **external** | **internal** } | [**level-1** | **level-1-2** | **level-2**] | **route-policy** *route-policy-name*] *
Configure not to import routes from other protocols	**undo import-route** *protocol* [**cost** *value* | **type** { **external** | **internal** } | [**level-1** | **level-1-2** | **level-2**] | **route-policy** *route-policy-name*] *

If the level is not specified in the command for importing the route, it defaults to importing the routes into **level-2**.

protocol specifies the routing protocol sources that can be imported, which can be direct, static, rip, bgp, and ospf, etc.

By default, IS-IS does not import routing information from any other protocols.

For more about importing routing information, see "IP Routing Policy".

Configuring IS-IS Route Filtering

The IS-IS protocol can filter the received and distributed routes according to the access control list specified by *acl-number*.

Perform the following configurations in IS-IS view.

Configuring for Filtering of the Routes Received by IS-IS

Table 83 Configuring for Filtering of Received Routes

Operation	Command
Allow filtering of received routes	**filter-policy** *acl-number* **import**
Prevent filtering of received routes	**undo filter-policy** *acl-number* **import**

Configuring for Filtering the Distributed Routes

Table 84 Configuring for Filtering of Distributed Routes

Operation	Command
Allow filtering of routes distributed by IS-IS	**filter-policy** *acl-number* **out** *protocol*
Prevent filtering of routes distributed by IS-IS	**undo filter-policy** *acl-number* **out** *protocol*

By default, IS-IS does not filter received and distributed routing information.

Protocol specifies the routing protocol sources for distributing routes, which can be direct, static, rip, bgp, ospf, or ospf-ase.

For more information, see "Configuring for Filtering Received Routes" and "Configuring for Filtering Distributed Routes ".

Setting the Preference of the IS-IS Protocol

In a router where several routing protocols are concurrently operating, there is an issue of sharing and selecting the routing information among all the routing protocols. The system sets a preference for each routing protocol. When various routing protocols find the route to the same destination, the route learned by the protocol with the higher preference will take effect.

Perform the following configurations in IS-IS view..

Table 85 Configuring the Preference of IS-IS Protocol

Operation	Command
Configure the preference of IS-IS protocol	**preference** *value*
Restore the default preference of IS-IS protocol	**undo preference**

By default, the preference of IS-IS routes is 15.

Resetting All the IS-IS Data Structures

When it is necessary to refresh some LSPs immediately, perform the following configuration in user view. This may be necessary if you change area or domain authentication parameters.

Table 86 Resetting all the IS-IS Data Structures

Operation	Command
Reset the IS-IS data structure	**reset isis all**

Resetting the Specified IS-IS Peer

When it is necessary to reset peer relationships, perform the following configuration in user view..

Table 87 Resetting the Specified IS-IS Peer

Operation	Command
Reset the specified IS-IS peer	**reset isis peer** *system-id*

Displaying and Debugging IS-IS

Using the following configuration operations, you can view the IS-IS LSDB , the transmission/receipt of IS-IS packets, IS-IS configuration, and information related to the IS-IS SFP calculation and IS-IS route table.

Execute the **display** command in all views to display the IS-IS configuration, and to verify the effect of the configuration. Execute the **debugging** command in user view to debug the IS-IS module.

Table 88 Displaying and Debugging IS-IS

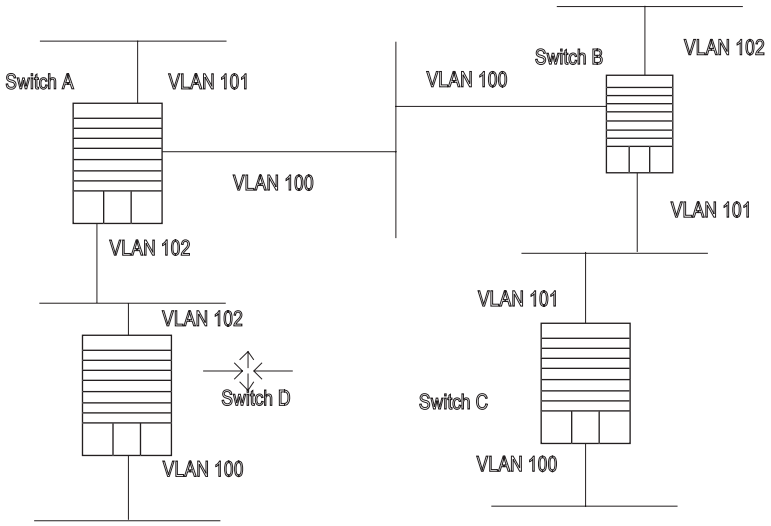
Operation	Command
Display IS-IS LSDB	**display isis lsdb** [[**l1** | **l2** | **level-1** | **level-2**] | [[*LSPID* | **local]** | **verbose**]*]*
Display IS-IS SPF calculation log	**display isis spf-log**
Display IS-IS routing information	**display isis route**
Display IS-IS neighbor information	**display isis peer** [**verbose**]
Display mesh group information	**display isis mesh-group**
Debug IS-IS adjacency packets	**debugging isis adjacency**
Debug IS-IS LSP checksum errors	**debugging isis checksum-error**
Debug IS-IS local update packets	**debugging isis self-originated-update**
Debug IS-IS LSP errors.	**debugging isis general-error**
Debug IS-IS SNP packets	**debugging isis snp-packet**
Debug IS-IS SPF events.	**debugging isis spf-event**
Debug IS-IS SPF computing statistics	**debugging isis spf-summary**
Debug IS-IS SPF triggers.	**debugging isis spf-timer**
Debug IS-IS update packets	**debugging isis update-packet**

Integrated IS-IS Configuration Example

As is shown in Figure 11, Switches A, B, C and D belong to the same autonomous system. The IS-IS routing protocol is run in these four switches to implement route interconnection. In network design, switches A, B, C and D belong to the same area.

This example shows only the IS-IS configuration. You must also configure IP addresses on the vlan interface of each switch.

Figure 11 IS-IS Configuration Example



1 Configure Switch A

```
[Switch A]isis
[Switch A-isis]network-entity 86.0001.0000.0000.0005.00
[Switch A]interface vlan-interface 100
[Switch A-Vlan-interface100]isis enable
[Switch A]interface vlan-interface 101
[Switch A-Vlan-interface101]isis enable
[Switch A]interface vlan-interface 102
[Switch A-Vlan-interface102]isis enable
```

2 Configure Switch B

```
[Switch B]isis
[Switch B-isis]network-entity 86.0001.0000.0000.0006.00
[Switch B]interface vlan-interface 101
[Switch B-Vlan-interface101]isis enable
[Switch B]interface vlan-interface 102
[Switch B-Vlan-interface102]isis enable
[Switch B]interface vlan-interface 100
[Switch B-Vlan-interface100]isis enable
```

3 Configure Switch C

```
[Switch C]isis
[Switch C-isis]network-entity 86.0001.0000.0000.0007.00
[Switch C]interface vlan-interface 101
```

```
[Switch C-Vlan-interface101]isis enable

[Switch C]interface vlan-interface 100

[Switch C-Vlan-interface100]isis enable
```

4 Configure Switch D

```
[Switch D]isis

[Switch D-isis]network-entity 86.0001.0000.0000.0008.00

[Switch D]interface vlan-interface 102

[Switch D-Vlan-interface102]isis enable

[Switch D]interface vlan-interface 100

[Switch D-Vlan-interface100]isis enable
```

BGP

Border gateway protocol (BGP) is an inter-autonomous system (inter-AS) dynamic route discovery protocol.

Three early versions of BGP are BGP-1 (RFC1105), BGP-2 (RFC1163) and BGP-3 (RFC1267). The current version is BGP-4 (RFC1771) that is applied to distributed structures and supports classless inter-domain routing (CIDR). BGP-4 is becoming the external routing protocol standard of the Internet, which is frequently used between ISPs.

The characteristics of BGP are as follows:

- BGP is an external gateway protocol (EGP) that focuses on route propagation control and selection of best routes, rather than the discovery and calculation of routes.
- It eliminates routing loops by adding AS path information to BGP routes.
- It enhances its own reliability by using TCP as the transport layer protocol.
- When routes are updated, BGP only transmits updated routes, which greatly reduces bandwidth occupation by route propagation and can be applied to propagation of a great amount of routing information on the Internet.
- BGP-4 supports CIDR, which is an important improvement over BGP-3.
- In consideration of management and security, users can perform control over outgoing and incoming routing information of each AS. BGP-4 provides abundant route policies to implement flexible filtering and selecting of routes.
- BGP-4 can be scaled easily to support new developments of the network.

CIDR does not distinguish networks of Class A, Class B and Class C. For example, an invalid Class C network address 192.213.0.0 (255.255.0.0) can be expressed as 192.213.0.0/16 in CIDR mode, which is a valid super network. Here /16 means that the subnet mask is composed of the first 16 bits from the left.

The introduction of CIDR simplifies route aggregation, which is the process of aggregating several different routes, and converts the advertisement processes of several routes to the advertisement of single route to simplify the routing table.

BGP runs on a router in any of the following modes:

- Internal BGP (IBGP)
- External BGP (EBGP)

BGP is called IBGP when it runs within an AS and EBGP when it runs among different ASs.

Configuring BGP is described in the following sections:

- BGP Messages
- BGP Routing
- BGP Peers and Peer Groups
- Configuring BGP
- Typical BGP Configuration Examples
- Troubleshooting BGP

BGP Messages

BGP is driven by the following types of messages:

- Open — Sent after a connection is created between BGP peers.
- Update — Used to exchange routing information between peers. This message has up to three parts
  - Unreachable route
  - Path attributes
  - Network layer reachability information (NLRI).
- Notification — Used for error notification.
- Keepalive — Used to check connectivity to peers.
- Route-refresh — Used to advertise its own route refreshing capability.

The open, update, notification and keepalive messages are defined in RFC1771, while the route-refresh message is defined in RFC2918 (Route Refresh Capability for BGP-4).

BGP Routing

At startup of the BGP session, the BGP router exchanges routing information with its peers by transmitting the complete BGP routing table. After that, only update messages are exchanged. During operation of the system, keepalive messages are received and transmitted to check the connections between various neighbors.

The router transmitting BGP messages is called a BGP speaker, which receives and generates new routing information continuously and advertises the information to the other BGP speakers. When a BGP speaker receives a new route advertisement from another AS, it will advertise the route to all other BGP speakers in the AS, if the route is better than the current route, or is a new route.

A BGP speaker calls other BGP speakers *peers.* Multiple related peers compose a *peer group*.

Route Advertisement Policy

In the Switch 8800, BGP uses the following policies when it advertises routes:

- If there are multiple routes available, a BGP speaker only selects the optimum one.
- A BGP speaker only advertises its own route to its peers.
- A BGP speaker advertises the routes obtained from EBGP to all its BGP peers (including EBGP and IBGP peers).
- A BGP speaker does not advertise the routes obtained from IBGP to its other IBGP peers.
- Once the connection is set up, a BGP speaker will advertise all its BGP routes to its peers.

Router Selection Policy

In the Switch 8800, BGP uses the following policies when it selects routes:

- Discard the routes from an unreachable or unknown next hop.
- Select the routes with the highest local preference.
- Select the routes that originate at the router itself.
- Select the routes with the lowest number of AS-paths.
- Select the routes with the lowest origin.
- Select the routes with the lowest MED value.
- Select the routes learned from EBGP.
- Select the routes advertised by the router with the lowest ID.

BGP Peers and Peer Groups

A BGP speaker calls other BGP speakers, peers, when they exchange information. Multiple related peers compose of a peer group.

In the Switch 8800, a BGP peer must belong to a peer group. If you want to configure a BGP peer, you first need to create a peer group and then add a peer into that group.

BGP peer group feature can simplify user configuration and improve route advertisement efficiency. When added into a peer group, a peer inherits all the configuration of the group.

If the configuration of a peer group changes, the configuration of its member peers also changes. Some attributes can be configured to a particular member peer by specifying its IP address. The attributes configured in this way have a higher priority than those configured for a peer group. Note that all member peers must use the same update policy as its group, but may use a different ingress policy.

Configuring BGP

BGP configuration includes:

- Enabling BGP
- Entering Extended Address Family View
- Configuring Basic Features for a BGP Peer

- Configuring Application Features of BGP Peer (Group)
- Configuring the Route Filtering of a Peer (Group)
- Configuring Networks for BGP Distribution
- Configuring Interaction Between BGP and IGP
- Configuring BGP Route Summarization
- Configuring BGP Route Filtering
- Configuring BGP Route Dampening
- Configuring BGP Preferences
- Configuring the BGP Timer
- Configuring Local Preferences
- Configuring MED for AS
- Comparing the MED Routing Metrics from Peers in Different ASs
- Configuring BGP Community
- Configuring a BGP Route Reflector
- Configuring BGP AS Confederation Attributes
- Defining ACLs, AS Path List, and Route-policy
- Clearing the BGP Connection
- Refreshing BGP Routes
- Displaying and Debugging BGP

Enabling BGP

To enable BGP, a local AS number must be specified. After BGP is enabled, the local router listens to BGP connection requests sent by adjacent routers. To make the local router send BGP connection requests to adjacent routers, refer to the configuration of the **peer** command. When BGP is disabled, all established BGP connections will be disconnected.

Perform the following configurations in system view.

Table 89 Enabling/Disabling BGP

Operation	Command
Enable BGP and enter the BGP view	**bgp** *as-number*
Disable BGP	**undo bgp** [*as-number*]

By default, BGP is not enabled.

Entering Extended Address Family View

To initiate multicast applications with BGP, you must enable BGP and enter the corresponding extended address family view. Some commands available in BGP view can also be executed in extended address family view. However, these commands are only available for the corresponding applications if you configure them in extended address family view.

Perform the following configurations in BGP view.

Table 90 Entering Extended Address Family View

Operation	Command
Enter multicast sub-address family view	**ipv4-family multicast**
Delete multicast sub-address family configuration	**undo ipv4-family multicast**

Use the **undo** command to delete the application configuration. See "Multicast Protocol" on page 63 for MBGP configuration commands.

Configuring Basic Features for a BGP Peer

In configuring a MBGP peer (group), you should first configure AS ID for it and then enter the corresponding address family view to activate the association.

Perform the configurations in the following subsections in BGP view.

Creating a Peer Group

A BGP peer must belong to a peer group. Before configuring a BGP peer, you must create a peer group to which the peer will belong.

Table 91 Creating a Peer Group

Operation	Command
Create a peer group	**group** *group-name* [**internal** | **external**]
Delete a specified peer group	**undo group** *group-name*

There are two types of BGP peer groups, IBGP and EBGP. Use **internal** to create a IBGP peer group. Use **external** to create a EBGP peer group and sub-AS peer groups inside a confederation.

The default type of BGP peer group is **internal**.

Configuring the AS Number of an EBGP Peer Group

You can specify the AS number for an EBGP peer group, but an IBGP peer group needs no AS number. When a peer group is specified with an AS number, all its member peers inherit that AS number.

Table 92 Configuring the AS Number of an EBGP Peer Group

Operation	Command
Configure the AS number of the EBGP peer group	**peer** *group-name* **as-number** *as-number*
Delete the AS number of the EBGP peer group	**undo peer** *group-name* **as-number** *as-number*

The AS number cannot be specified for a peer group which already has group numbers. Deleting the AS number of a peer group deletes all member peers in that group.

Adding a Member to a Peer Group

A BGP peer must belong to a peer group. If you want to configure a BGP peer, you need to first create a peer group and then add a peer to the group.

Table 93 Creating a Peer Group and Add a Member

Operation	Command
Add a peer to the peer group	**peer** *peer-address* **group** *group-name* [**as-number** *as-number*]
Delete a peer	**undo peer** *peer-address*

If a peer is added to an IBGP peer group, the AS number cannot be specified in the command.

When a peer group is defined with an AS number, all its member peers inherit that AS number. If the AS number of the peer group is not specified, each peer added to it should be specified with its own AS number. AS numbers of peers in a same peer group can be different.

Configuring the State of a Peer/Peer Group

A BGP peer/peer group has two states: enable and disable. The BGP speakers do not exchange routing information with a disabled peer or peer group.

Perform the following configurations in BGP view.

Table 94 Configuring the State of a Peer/Peer Group

Operation	Command
Enable a peer/peer group	**peer** { *group-name* | *peer-address* } **enable**
disable a peer/peer group	**undo peer** { *group-name* | *peer-address* } **enable**

By default, a BGP peer or peer group is enabled.

When exchanging routing information between BGP speakers, the peer group must be enabled first, and then the peer should be added to the enabled peer group.

Configuring the Description of a Peer (Group)

The description of a peer or peer group can be added to facilitate learning the characteristics of the peer .

Table 95 Configuring the Description of a Peer Group

Operation	Command
Configure description of a peer (group)	**peer** { *peer-address* | *group-name* } **description** *description-line*
Delete description of a peer (group)	**undo peer** { *peer-address* | *group-name* } **description**

By default, no BGP peer (group) description is set.

Configuring the Timer of a Peer (Group)

The **peer timer** command is used to configure timers of BGP peer (group), including the keep-alive message interval and the hold timer. The preference of

this command is higher than the timer command, which is used to configure timers for the whole BGP peers.

Table 96 Configuring the Timer of a Peer Group

Operation	Command
Configure keep-alive message interval and hold timer of peer (group)	**peer** { *group-name* | *peer-address* } **timer keep-alive** *keepalive-interval* **hold** *holdtime-interval*}
Restore the default value of keep-alive message interval and hold timer of a peer (group)	**undo peer** { *group-name* | *peer-address* } **timer**

By default, the keep-alive message is sent every 60 seconds and the value of the hold timer is 180 seconds.

Configuring the Route Update Interval for a Peer Group

Table 97 Configuring the Route Update Interval for a Peer Group

Operation	Command
Configure the route update message interval of a peer group	**peer** *group-name* **route-update-interval** *seconds*
Restore the default route update message interval of a peer group	**undo peer** *group-name* **route-update-interval**

By default, the intervals at which route update messages are sent by an IBGP and EBGP peer group are 5 seconds and 30 seconds respectively.

Configuring Application Features of BGP Peer (Group)

Configuring Connection Permission with EBGP Peer Groups on Indirectly Connected Networks

Generally, EBGP peers must be directly connected. The following command can be used to configure two indirectly connected EBGP peers or peer groups.

Table 98 Configuring Connection Permission with EBGP Peer Groups on Indirectly Connected Networks

Operation	Command
Permit connections with EBGP peer groups on indirectly connected networks	**peer** *group-name* **ebgp-max-hop** [*ttl*]
Permit connections with EBGP peer groups on directly connected network only.	**undo peer** *group-name* **ebgp-max-hop**

By default, only connections with EBGP peer groups on directly connected networks are permitted. Ttl refers to the time-to-live in the range of 1 to 255. The default value is 64.

Configuring a Peer Group to be a Client of a Route Reflector .

Table 99 Configuring a Peer Group to be a Client of a Route Reflector

Operation	Command
Configure a peer group to be a client of a route reflector	**peer** *group-name* **reflect-client**
Cancel the configuration of making the peer group as the client of the BGP route reflector	**undo peer** *group-name* **reflect-client**

For detailed information on the route reflector, see "Configuring a BGP Route Reflector" on page 140.

Configuring Transmission of a Default Route to a Peer Group .

Table 100 Configuring Transmission of a Default Route to a Peer Group

Operation	Command
Configure transmission of a default route to a peer group	**peer** *group-name* **default-route-advertise**
Configure no transmission of a default route to a peer group	**undo peer** *group-name* **default-route-advertise**

By default, a local router does not send a default route to any peer group. However, if you use the **peer default-route-advertise** command, the local router sends a default route, with itself as the next hop, to the peer even if there is no default route in BGP routing table.

Configuring the BGP Router as the Next Hop in a Route

A BGP router can specify itself as the next hop while advertising a route to a peer group.

Table 101 Configuring the Advertiser as the Next Hop in a Route

Operation	Command
Configure itself as the next hop in advertising route	**peer** *group-name* **next-hop-local**
Disable the specification of itself as the next hop in advertising route	**undo peer** *group-name* **next-hop-local**

By default, local router does not specify itself as the next hop while advertising route to a peer group.

Removing Private AS Numbers When Transmitting BGP Update Messages

Generally, the AS numbers (public AS numbers or private AS numbers) are included in the AS paths while transmitting BGP update messages. This command is used to configure a local router not to transmit private AS numbers when transmitting update messages.

Table 102 Removing Private AS Numbers While Transmitting BGP Update Messages

Operation	Command
Remove private AS numbers while transmitting BGP update messages	**peer** *group-name* **public-as-only**
Include private AS numbers while transmitting BGP update messages	**undo peer** *group-name* **public-as-only**

By default, the private AS numbers are included when transmitting BGP update messages.

Configuring the Transmission of Community Attributes to a Peer Group

Table 103 Configuring for Transmission of Community Attributes to a Peer Group

Operation	Command
Configure to send the community attributes to a peer group	**peer** *group-name* **advertise-community**
Configure not to send the community attributes to a peer group	**undo peer** *group-name* **advertise-community**

Configuring the Repeating Time of a Local AS

Using the **peer allow-as-loop** command, the repeating time of local AS can be configured.

Perform the following configurations in BGP view..

Table 104 Configuring the Repeating Time of a Local AS

Operation	Command
Configure the repeating time of local AS	**peer** { *group-name* | *peer-address* } **allow-as-loop** [*number*]
Remove the repeating time of local AS	**undo peer** { group-name | peer-address } **allow-as-loop**

Specifying the Source Interface of a Route Update Packet

Generally, the system specifies the source interface of a route update packet. When the interface fails to work, in order to keep the TCP connection alive, the interior BGP session can be configured to specify the source interface. This command is usually used when using the loopback interface.

Table 105 Specifying the Source Interface of a Route Update Packet

Operation	Command
Specify the source interface of a route update packet	**peer** { *peer-address* | *group-name* } **connect-interface** *interface-type interface-name*
Use the best source interface	**undo peer** { *peer-address* | *group-name* } **connect-interface** *interface-type interface-name*

By default, BGP carries out TCP connection with the optimal source interface.

Configuring the BGP MD5 Authentication Password

BGP uses TCP as its transport layer. For security, you can configure a MD5 authentication password when setting up TCP connection. BGP MD5 authentication only sets a password for the TCP connection, but not for authenticating BGP packets. The authentication is implemented by TCP.

Perform the following configurations in BGP view.

Table 106 Configuring the BGP MD5 Authentication Password

Operation	Command
Configure MD5 authentication password	**peer** { *group-name* | *peer-address* } **password** { **cipher** | **simple** } *password*
Cancel MD5 authentication	**undo peer** { *group-name* | *peer-address* } **password**

In BGP, no authentication is performed in setting up TCP connections, by default.

The multicast extension configured in BGP view is also available in MBGP, because they use the same TCP link.

Configuring the Route Filtering of a Peer (Group)

The Switch 8800 supports filtering imported and advertised routes to peers (groups) through the route-policy, AS path list, ACL, and ip prefix list.

The route filtering policy of advertised routes, configured for each member of a peer group, must be the same as that of the peer group. However, their route filtering policies of ingress routes may be different.

Perform the following configurations in BGP view.

Configuring the Route Policy for a Peer (Group)

Table 107 Configuring the Route Policy for a Peer (Group)

Operation	Command
Configure the ingress route policy for a peer (group)	**peer** { *peer-address* | *group-name* } **route-policy** *route-policy-name* **import**
Remove the ingress route policy of a peer (group)	**undo peer** { *peer-address* | *group-name* } **route-policy** *policy-name* **import**
Configure egress route policy for a peer group	**peer** *group-name* **route-policy** *route-policy-name* **export**
Remove the egress route policy of a peer group	**undo peer** *group-name* **route-policy** *route-policy-name* **export**

By default, no route policy is applied to a peer or a peer group.

Configuring a Route Filtering Policy Based on IP ACL for a Peer (Group).

Table 108 Configuring a Route Filtering Policy Based on IP ACL for a Peer (Group)

Operation	Command
Configure the ingress route filtering policy based on IP ACL for a peer (group)	**peer** { *peer-address* | *group-name* } **filter-policy** *acl-number* **import**
Remove the ingress route filtering policy based on IP ACL of a peer (group)	**undo peer** { *peer-address* | *group-name* } **filter-policy** *acl-number* **import**
Configure the egress route filtering policy based on IP ACL for a peer group	**peer** *group-name* **filter-policy** *acl-number* **export**
Remove the egress route filtering policy based on IP ACL for a peer group	**undo peer** *group-name* **filter-policy** *acl-number* **export**

By default, route filtering based on IP ACL for a peer or peer group is disabled.

Configuring Route Filtering Policy Based on an AS Path List for a Peer (Group).

Table 109 Configuring Route Filtering Policy Based on an AS Path List for a Peer (Group)

Operation	Command
Configure the ingress route filtering policy based on AS path list for a peer (group)	**peer** { *peer-address* | *group-name* } **as-path-acl** *acl-number* **import**

Table 109 Configuring Route Filtering Policy Based on an AS Path List for a Peer (Group)

Operation	Command
Remove the ingress route filtering policy based on AS path list of a peer (group)	**undo peer** { *peer-address* | *group-name* } **as-path-acl** *acl-number* **import**
Configure the egress route filtering policy based on IP ACL for a peer group	**peer** *group-name* **as-path-acl** *acl-number* **export**
Remove the egress route filtering policy based on IP ACL for a peer group	**undo peer** *group-name* **as-path-acl** *acl-number* **export**

By default, route filtering based on an AS path list for a peer or peer group is disabled.

Configuring a Route Filtering Policy Based on Address Prefix List for a Peer (Group)

Table 110 Configuring a Route Filtering Policy Based on Address Prefix List for a Peer (Group)

Operation	Command
Configure the ingress route filtering policy based on address prefix list for a peer (group)	**peer** { *peer-address* | *group-name* } **ip-prefix** *prefixname* **import**
Remove the ingress route filtering policy based on address prefix list of a peer (group)	**undo peer** { *peer-address* | *group-name* } **ip-prefix** *prefixname* **import**
Configure the egress route filtering policy based on address prefix list for a peer group	**peer** *group-name* **ip-prefix** *prefixname* **export**
Remove the egress route filtering policy based on address prefix list for a peer group	**undo peer** *group-name* **ip-prefix** *prefixname* **export**

By default, route filtering based on address prefix list for a peer or peer group is disabled.

Configuring Networks for BGP Distribution

Perform the following configurations in BGP view..

Table 111 Configuring Networks for BGP Distribution

Operation	Command
Configure the local network route	**network** *ip-address address-mask* [**route-policy** *route-policy-name*]
Remove the local network route	**undo network** *ip-address address-mask* [**route-policy** *route-policy-name*]

By default, no network is configured for BGP distribution.

Configuring Interaction Between BGP and IGP

Importing IGP Route Information

BGP can transmit the internal network information of local AS to other AS. To reach such objective, the network information about the internal system learned by the local router via IGP routing protocol can be transmitted.

Perform the following configurations in BGP view..

Table 112 Importing IGP Routing Information

Operation	Command
Configure BGP to import routes of IGP protocol	**import-route** *protocol* [*process-id*] [**med** *med*] [**route-policy** *route-policy-name*]
Configure BGP not to import routes of IGP protocol	**undo import-route** *protocol*

By default, BGP does not import the route information of other protocols.

The specified and imported source route protocols can be direct, static, rip, isis, ospf, ospf-ase, and ospf-nssa.

After the **import-route** command is used in a certain BGP subview, the imported source route protocol will not be imported into BGP. Then you need to use the **default-route import** command in the corresponding view.

For detailed description of routing information, see "Importing Routing Information Discovered by Other Routing Protocols" on page 156.

Configuring BGP Route Summarization

The CIDR supports route summarization. There are two modes of BGP route summarization:

- Summary: The summary is the summary of the BGP subnet routes. After the configuration of the summary, the BGP will not be able to receive subnets imported by the IGP.
- Aggregate: The aggregate is the aggregation of the BGP local routes. A series of parameters can be configured in the aggregate. The preference of the aggregation is higher than that of the summarization.

Perform the following configuration in the BGP view.

Table 113 Configuring BGP Route Summarization

Operation	Command
Configure the summary function of the subnet routes	**summary**
Cancel the summary function of the subnet routes	**undo summary**
Configure local route aggregation function	**aggregate** *address mask* [**as-set** | **attribute-policy** *route-policy-name* | **detail-suppressed** | **origin-policy** *route-policy-name* | **suppress-policy** *route-policy-name*]*
Cancel local route aggregation function	**undo aggregate** *address mask* [**as-set** | **attribute-policy** *route-policy-name* | **detail-suppressed** | **origin-policy** *route-policy-name* | **suppress-policy** *route-policy-name*]*

By default, BGP will not perform local route aggregation.

Configuring BGP Route Filtering

Configuring BGP to Filter the Received Route Information

Perform the following configurations in BGP view.

The routes received by the BGP can be filtered, and only those routes that meet certain conditions will be received by the BGP.

Table 114 Configuring BGP to Filter the Received Route Information

Operation	Command
Configure received route filtering	**filter-policy** { *acl-number* | **ip-prefix** *ip-prefix-name* [**gateway** *ip-prefix-name*] } **import**
Cancel the received route filtering	**undo filter-policy** { *acl-number* | **ip-prefix** *ip-prefix-name* [**gateway** *ip-prefix-name*] } **import**

For details, see "Configuring BGP Route Dampening" on page 136.

Configuring the Filtering of Routes that are Distributed by BGP

The routes distributed by BGP can be filtered, and only those routes, which meet the certain conditions, will be distributed by the BGP.

Perform the following configuration in the BGP view:

Table 115 Configuring the Filtering of Routes that are Distributed by BGP

Operation	Command
Configure filtering of routes distributed by the BGP	**filter-policy** { *acl-number* | **ip-prefix** *ip-prefix-name* } **export** [*routing-process*]
Cancel filtering of the routes distributed by the BGP	**undo filter-policy** { *acl-number* | **ip-prefix** *ip-prefix-name* } **export** [*routing-process*]

By default, BGP will not filter the received distributed routes.

For details, see "Configuring BGP Route Filtering" on page 136.

Configuring BGP Route Dampening

The most possible reason for an unstable route is the intermittent disappearance and re-emergence of the route that formerly existed in the routing table. This situation is called route *flapping*. When flapping occurs, update packets are propagated on the network repeatedly, which consumes router bandwidth and processing time. Route dampening controls flapping.

Route dampening divides the route into a stable route and an unstable route. The unstable route is not advertised. The history performance of the route is the basis to evaluate the future stability. When route flapping occurs a penalty is given. When the penalty reaches a specific threshold, the route is suppressed. Over time, the penalty value decreases according to a power function, and when it decreases to a specified threshold, the route suppression is eliminated and the route is re-advertised.

Perform the following configurations in BGP view..

Table 116 Configuring BGP Route Dampening

Operation	Command
Configure BGP route dampening	**dampening** [*half-life-reachable half-life-unreachable reuse suppress ceiling*] [**route-policy** *route-policy-name*]

Table 116 Configuring BGP Route Dampening

Operation	Command
Clear route attenuation information and eliminating the suppression of the route	**reset dampening** [*network-address* [*mask*]]
Cancel BGP route dampening	**undo dampening**

By default, route dampening is disabled.

The parameters in the command are dependent on one another. If one parameter is configured, other parameters must be specified.

Configuring BGP Preferences

Three types of routes may be involved in BGP:

- Routes learned from external peers
- Routes learned from internal peers
- Routes with local origins

You can set preference values for the three types of routes.

Perform the following configurations in BGP view..

Table 117 Configuring BGP Preferences

Operation	Command
Configure BGP preference	**preference** *ebgp-value ibgp-value local-value*
Restore the default preference	**undo preference**

The ebgp-value, ibgp-value and local-value parameters are in the range of 1 to 256. By default, the first two is 256 and the last one is 130.

Configuring the BGP Timer

When receiving an open message to set up a BGP connection, a BGP speaker needs to calculate a hold timer. The smaller the gap between its own hold time and the one received in the message will be selected as the negotiated hold timer. Then, BGP will send a keepalive message and set a keepalive timer. If the negotiation result is 0, no keepalive message is transmitted and the *holdtime-interval* value is ignored.

Perform the following configurations in BGP view..

Table 118 Configuring the BGP Timer

Operation	Command
Configure BGP Timer	**peer** { *group-name* | *peer-address* } **timer keep-alive** *keepalive-interval* **hold** *holdtime-interval*
Restore the default value of the timer	**peer** { *group-name* | *peer-address* } **timer**

By default, the interval for sending keepalive packet is 60 seconds. The interval for sending holdtime packet is 180 seconds.

Configuring Local Preferences

Different local preferences can be configured to affect BGP routing. When a router running BGP gets routes with the same destination address but different next hops through different internal peers, it will select the route with the highest local preference.

Perform the following configurations in BGP view..

Table 119 Configuring the Local Preferences

Operation	Command
Configure the local preference	**default local-preference** *value*
Restore the default local preference	**undo default local-preference**

The local preference is transmitted only when the IBGP peers exchange the update packets and it will not be transmitted beyond the local AS.

By default, the local preference is 100.

Configuring MED for AS

The Multi-Exit Discriminators (MED) attribute is the external metric for a route. It is exchanged between ASs. However, it will not be transmitted beyond an AS once it is imported into the AS.

AS uses the local preference to select the route to the outside and MED to determine the optimum route for entering the AS. When a router running BGP receives routes with the same destination address but different next hops through different external peers, it will select the route of the smallest MED as the optimum route, provided that all the other conditions are the same.

Perform the following configurations in BGP view..

Table 120 Configuring a MED Value for the System

Operation	Command
Configure a MED value for the system	**default med** *med-value*
Restore the default MED value of the system	**undo default med**

The router configured above only compares the route MED metrics of different EBGP peers in the same AS. Using the **compare-different-as-med** command, you can compare the route MED metrics of the peers in different ASs.

By default, MED metric is 0.

Comparing the MED Routing Metrics from Peers in Different ASs

Comparison of MED routing metrics is performed to select the best route. The route with smaller MED value will be selected.

Perform the following configurations in BGP view..

Table 121 Comparing the MED Routing Metrics from Peers in Different ASs

Operation	Command
Compare the MED routing metrics from peers in different ASs	**compare-different-as-med**
Do not compare the MED routing metrics from peers in different ASs	**undo compare-different-as-med**

By default, MED comparison is not allowed among routes from neighbors in different ASs.

You should not use this configuration unless you can make sure that the ASs adopt the same IGP routing method.

Configuring BGP Community

Community attributes are optional and transitive. Some community attributes are globally recognized, which are called standard community attributes, whereas some are for special purposes which are called extended community attributes. You may define not only the standard community, but also the extended community attributes.

Community-list is used to identify a community, which falls into standard community-list and extended community-list.

In addition, a route can have more than one community attribute. In a route, the speaker of multiple community attributes can act according to one, several, or all of the attributes. A router can choose to change the community attribute or leave it unchanged before transmitting the route to its peers.

Perform the following configurations in system view..

Table 122 Configuring Community

Operation	Command
Configure a standard community list	**ip community-list** *standard-community-list-number* { **permit** | **deny** } { *aa:nn* | **internet** | **no-export-subconfed** | **no-advertise** | **no-export** }
Configure an extended community list	**ip community-list** *extended-community-list-number* { **permit** | **deny** } *as-regular-expression*
Remove the configured community list	**undo ip community-list** { *standard-community-list-number* | *extended-community-list-number* }

By default, no BGP community is configured.

Configuring a BGP Route Reflector

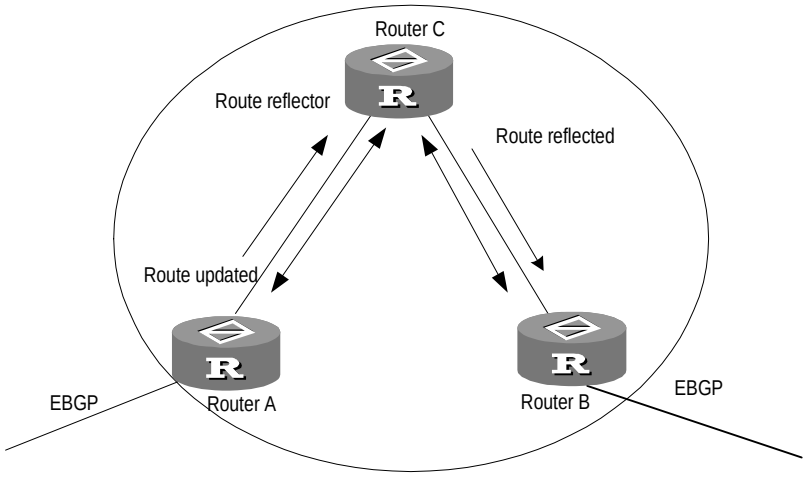
To ensure the interconnection between IBGP peers, it is necessary to establish a fully meshed network. In some networks, there are large numbers of IBGP peers so the cost to establish a fully meshed network is large. Thus, it is necessary to configure a route reflector which specifies a centralized router as the focus of the internal session.

The route reflector is the centralized point for other routers, called *clients*. The client is the peer of the route reflector and exchanges routing information with it. The route reflector reflects information among the clients. A single route reflector can have multiple clients. Each client, in turn, can be a route reflector with multiple clients.

In the following figure, Router A receives an update packet from the external peer and transmits it to Router C. Router C is a route reflector with two peer clients: Router A and Router B.

Router C reflects the update packet from client Router A to client Router B. In this configuration, the peer session between Router A and Router B is actually eliminated because the route reflector will transfer the BGP information to Router B.

Figure 12 Route Reflector Diagram



The reflector is the router that can complete the route reflection function. The route reflector regards the IBGP peers as client and non-client. All peers that do not belong to this cluster in the autonomous system are the non-clients. The designation of route reflector and the addition of the client peer are implemented with the **peer reflect-client** command.

Configuring the Route Reflection Between Clients

Perform the following configurations in BGP view..

Table 123 Configuring the Route Reflection Between Clients

Operation	Command
Enable route reflection between clients	**reflect between-clients**
Disable route reflection between clients	**undo reflect between-clients**

By default, route reflection between clients is enabled.

Configuring the Cluster ID

Generally, there is only one route reflector in a cluster.

Perform the following configurations in BGP view..

Table 124 Configuring the Cluster ID

Operation	Command
Configure the Cluster_ID of the route reflector	**reflector cluster-id** { *cluster-id* | *address* }
Canceling the Cluster_ID of the route reflector	**undo reflector cluster-id**

By default, the router ID of the route reflector is used as the cluster ID.

Two Measures to Avoid Looping Inside an AS

As route reflector is imported, it is possible that path looping will be generated in AS. Path update packets that already left the cluster may attempt to return to the cluster. The conventional AS path method can not detect the internal AS looping, because the path update packet has not left AS. Upon configuring route reflector, BGP provides the following measures to avoid internal AS looping:

1 Configure the Originator_ID of the route reflector

The Originator_ID is established by the route reflector. The originator drops the update packet and returns it to the originator if it is an improper configuration.

The parameter is not necessarily configured, and it will automatically function after BGP is enabled.

2 Configure the Cluster_ID of the route reflector

Configuring BGP AS Confederation Attributes

Confederation provides a method to handle the booming IBGP network connections inside AS. It divides the AS into multiple sub-AS, in each, all IBGP peers are fully connected, and are connected with other sub-AS of the confederation.

The shortcomings of confederation: it is required that the route be re-configured upon switching from non-confederation to confederation solution, and that the logic topology be basically changed. Furthermore, the path selected via confederation may not be the best path if there is no manually set BGP policy.

Configuring the Confederation ID

In the eye of the BGP speakers that are not part of the confederation, multiple sub-AS's that belong to the same confederation appear as a single unit. The external network does not need to know the status of internal sub-AS's, and the confederation ID is the AS number identifying the confederation as a whole.

Perform the following configurations in BGP view..

Table 125 Configuring the Confederation ID

Operation	Command
Configure confederation_ID	**confederation id** *as-number*
Canceling confederation_ID	**undo confederation id**

By default, the confederation_ID is not configured.

Configure a Sub-AS Within the Confederation

Configure the confederation_ID first, and then configure the sub-AS that belongs to the confederation. One confederation can include up to 32 sub-AS's. The AS-number that is used when configuring the sub-AS as part of the confederation is valid within the confederation.

Perform the following configurations in BGP view..

Table 126 Configuring a Sub-AS Belonging to the Confederation

Operation	Command
Configure a confederation consisting of sub-ASs	**confederation peer-as** *as-number-1* [... *as-number-n*]

Table 126 Configuring a Sub-AS Belonging to the Confederation

Operation	Command
Remove the specified sub-AS from the confederation	**undo confederation peer-as** [*as-number-1*] [*...as-number-n*]

By default, no autonomous systems are configured as a member of the confederation.

Configure the AS Confederation Nonstandard

If it is necessary to perform the interconnection with devices whose BGP implementation confederation is different from that of RFC1965, you must configure all the routers in the confederation.

Perform the following configurations in BGP view..

Table 127 Configuring AS Confederation Attribute Compatible with Nonstandard

Operation	Command
Configure AS confederation attribute compatible with nonstandard router	**confederation nonstandard**
Cancel AS confederation attribute compatible with nonstandard router	**undo confederation nonstandard**

By default, the configured confederation is consistent with RFC1965.

Defining ACLs, AS Path List, and Route-policy

This section describes the configuration of ACL, AS path list, and Route-policy.

Defining the ACL See "Defining ACLs" on page 211

Defining the AS path list

The routing information packet of BGP includes an AS path domain. The AS path-list can be used to match the autonomous system path domain of the BGP routing information to filter the routing information which does not conform to the requirements. For the same list number, the user can define multiple portions of the AS path-list, i.e. a list number stands for a group of AS path ACLs. Each AS path list is identified with a number.

Perform the following configurations in system view: .

Table 128 Defining the AS path list

Operation	Command
Define the AS path list	**ip as-path-acl** *acl-number* { **permit** | **deny** } *as-regular-expression*
Delete the specified AS list	**undo ip as-path-acl** *acl-number*

By default, no AS path list is defined.

During the matching, the relationship of "OR" is available between the members (acl-number) of the ACLs, so that when the routing information passes through one piece of this group of lists, it means that the routing information has been filtered by this group of as-path lists identified with this list number.

Defining Route-policy See "Defining Route-policy" on page 143.

Defining Match Principle See "Defining If-match Clauses for a Route Policy" on page 154.

Defining Evaluation Rules See "Defining Apply Clauses for a Route Policy" on page 155.

Clearing the BGP Connection

After you change a BGP policy or protocol configuration, you must reset the current BGP connection to enable the new configuration.

Perform the following configuration in user view.

Table 129 Clearing the BGP Connection

Operation	Command
Clear the connection between BGP and the specified peers	**reset bgp** *peer-address* [**flap-info**]
Clear all connections of BGP	**reset bgp all**
Clear the connections between the BGP and all the members of a group	**reset bgp group** *group-name*

Refreshing BGP Routes

When a BGP routing policy changes, the associated route information must be recomputed.

Perform the following configuration in user view..

Table 130 Refreshing BGP Routes

Operation	Command
Refreshing general BGP routes	**refresh bgp** { **all** | *peer-address* | **group** *group-name* } { **import** | **export** }

The import keyword means to refresh the routes learned from the peers and the export keyword means to refresh routes advertised to the peers.

Displaying and Debugging BGP

After creating the configuration, execute the **display** command in any view to display the BGP configuration, and to verify the effect of the configuration. Execute the **reset** command in user view to clear the statistics of the configuration. Execute the **debugging** command in user view to debug the configuration. Execute the **reset** command in user view to reset the BGP statistic information.

Table 131 Displaying and Debugging BGP

Operation	Command
Display the routing information of the BGP	**display bgp routing-table** [*ip-address* [*mask*]]
Display filtered AS path information in the BGP	**display ip as-path-acl** *acl-number*
Display CIDR routes	**display bgp routing-table cidr**
Display the routing information of the specified BGP community	**display bgp routing-table community** [*aa:nn* | **no-export-subconfed** | **no-advertise** | **no-export**]* [**whole-match**]
Display the routing information allowed by the specified BGP community list	**display bgp routing-table community-list** *community-list-number* [**whole-match**]

Table 131 Displaying and Debugging BGP

Operation	Command
Display BGP dampened paths	**display bgp routing-table dampened**
Display the routing information the specified BGP peer advertised or received	**display bgp routing-table peer** *peer-address* { **advertised** | **received** } [*network-address* [*mask*] | **statistic**]
Display the routes matching with the specified access-list	**display bgp routing-table as-path-acl** *acl-number*
Display route flapping statistics information	**display bgp routing-table flap-info** [{ **regular-expression** *as-regular-expression* } | { **as-path-acl** *acl-number* } | { *network-address* [*mask* [**longer-match**]] }]
View routes with different source ASs	**display bgp routing-table different-origin-as**
Display neighbors information	**display bgp peer** *peer-address* **verbose** **display bgp peer** [**verbose**]
Display the routing information that has been configured	**display bgp network**
Display AS path information	**display bgp paths** *as-regular-expression*
Display peer group information	**display bgp group** [*group-name*]
Display the information on BGP routes which is mapped to a certain regular expression	**display bgp routing-table regular-expression** *as-regular-expression*
Display configured route-policy information	**display route-policy** [*policy-name*]
Enable information debugging of all BGP packets	**debugging bgp all**
Enable BGP event debugging	**debugging bgp event**
Enable BGP Keepalive debugging	**debugging bgp keepalive** [**receive** | **send**] [**verbose**]
Enable BGP Open debugging	**debugging bgp open** [**receive** | **send**] [**verbose**]
Enable BGP packet debugging	**debugging bgp packet** [**receive** | **send**] [**verbose**]
Enable BGP Update packet debugging	**debugging bgp route-refresh** [**receive** | **send**] [**verbose**]
Enable information debugging of BGP normal functions.	**debugging bgp normal**
Enable BGP Update packet debugging	**debugging bgp update** [**receive** | **send**] [**verbose**]
Reset BGP flap information	**reset bgp flap-info** [**regular-expression** *as-regular-expression* | **as-path-acl** *acl-number* | *network-address* [*mask*] }]

Typical BGP Configuration Examples

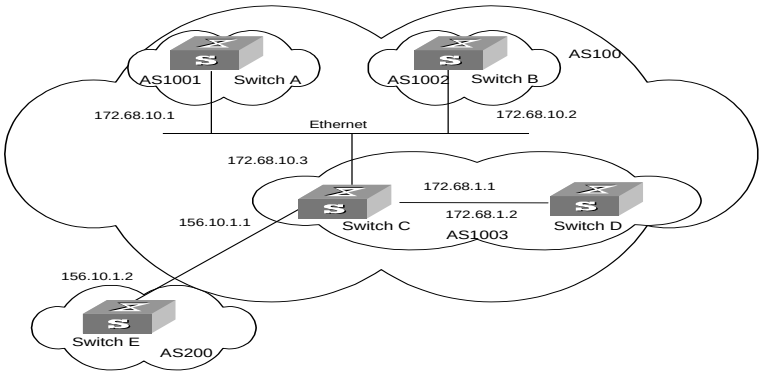
Typical BGP Configuration Examples are described as follows:

- Configuring the BGP AS Confederation Attribute
- Configuring BGP Route Reflector
- Configuring BGP Routing

Configuring the BGP AS Confederation Attribute

Divide the following AS 100 into three sub-AS: 1001, 1002, and 1003, and configure EBGP, confederation EBGP, and IBGP.

Figure 13 AS Confederation Configuration



To configure the AS confederation:

1 Configure Switch A:

```
[Switch A]bgp 1001
[Switch A-bgp]confederation id 100
[Switch A-bgp]confederation peer-as 1002 1003
[Switch A-bgp]group confed1002 external
[Switch A-bgp]peer confed1002 as-number 1002
[Switch A-bgp]group confed1003 external
[Switch A-bgp]peer confed1003 as-number 1003
[Switch A-bgp]peer 172.68.10.2 group confed1002
[Switch A-bgp]peer 172.68.10.3 group confed1003
```

2 Configure Switch B:

```
[Switch B]bgp 1002
[Switch B-bgp]confederation id 100
[Switch B-bgp]confederation peer-as 1001 1003
[Switch B-bgp]group confed1001 external
[Switch B-bgp]peer confed1001 as-number 1001
[Switch B-bgp]group confed1003 external
[Switch B-bgp]peer confed1003 as-number 1003
[Switch B-bgp]peer 172.68.10.1 group confed1001
[Switch B-bgp]peer 172.68.10.3 group confed1003
```

3 Configure Switch C:

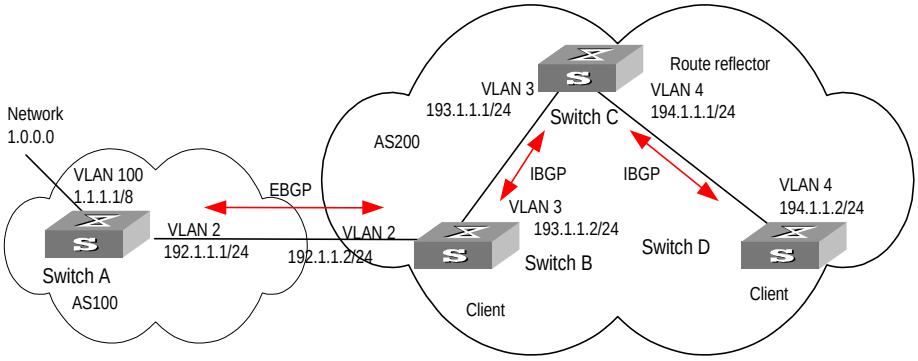
```
[Switch C]bgp 1003
[Switch C-bgp]confederation id 100
[Switch C-bgp]confederation peer-as 1001 1002
[Switch C-bgp]group confed1001 external
[Switch C-bgp]peer confed1001 as-number 1001
[Switch C-bgp]group confed1002 external
[Switch C-bgp]peer confed1002 as-number 1002
[Switch C-bgp]peer 172.68.10.1 group confed1001
[Switch C-bgp]peer 172.68.10.2 group confed1002
[Switch C-bgp]group ebgp200 external
[Switch C-bgp]peer 156.10.1.2 group ebgp200 as-number 200
[Switch C-bgp]group ibgp1003 internal
[Switch C-bgp]peer 172.68.1.2 group ibgp1003
```

Configuring BGP Route Reflector

Switch B receives an update packet passing EBGP and transmits it to Switch C. Switch C is a reflector with two clients: Switch B and Switch D. When Switch C

receives a route update from Switch B, it will transmit such information to Switch D. You must establish an IBGP connection between Switch B and Switch D, because Switch C reflects information to Switch D.

Figure 14 BGP Route Reflector Configuration



1 Configure Switch A:

```
[Switch A]interface vlan-interface 2
[Switch A-Vlan-interface2]ip address 192.1.1.1 255.255.255.0
[Switch A-Vlan-interface2]interface Vlan-interface 100
[Switch A-Vlan-interface100]ip address 1.1.1.1 255.0.0.0
[Switch A-Vlan-interface100]quit
[Switch A]bgp 100
[Switch A-bgp]network 1.0.0.0 255.0.0.0
[Switch A-bgp]group ex external
[Switch A-bgp]peer 192.1.1.2 group ex as-number 200
```

2 Configure Switch B:

a Configure VLAN 2:

```
[Switch B]interface Vlan-interface 2
[Switch B-Vlan-interface2]ip address 192.1.1.2 255.255.255.0
```

b Configure VLAN 3:

```
[Switch B]interface Vlan-interface 3
[Switch B-Vlan-interface3]ip address 193.1.1.2 255.255.255.0
```

c Configure peers.

```
[Switch B]bgp 200
[Switch B-bgp]group ex external
[Switch B-bgp]peer 192.1.1.1 group ex as-number 100
[Switch B-bgp]group in internal
[Switch B-bgp]peer 193.1.1.1 group in
```

3 Configure Switch C:

a Configure VLAN 3:

```
[Switch C]interface Vlan-interface 3
[Switch C-Vlan-interface3]ip address 193.1.1.1 255.255.255.0
```

b Configure VLAN 4:

```
[Switch C]interface vlan-Interface 4
[Switch C-Vlan-interface4]ip address 194.1.1.1 255.255.255.0
```

c Configure BGP peers and route reflector.

```
[Switch C]bgp 200
[Switch C-bgp]group rr internal
[Switch C-bgp]peer rr reflect-client
[Switch C-bgp]peer 193.1.1.2 group rr
[Switch C-bgp]peer 194.1.1.2 group rr
```

4 Configure Switch D:

a Configure VLAN 4:

```
[Switch D]interface vlan-interface 4
[Switch D-Vlan-interface4]ip address 194.1.1.2 255.255.255.0
```

b Configure BGP peers

```
[Switch D]bgp 200
group in internal
[Switch D-bgp]peer 194.1.1.1 group in
```

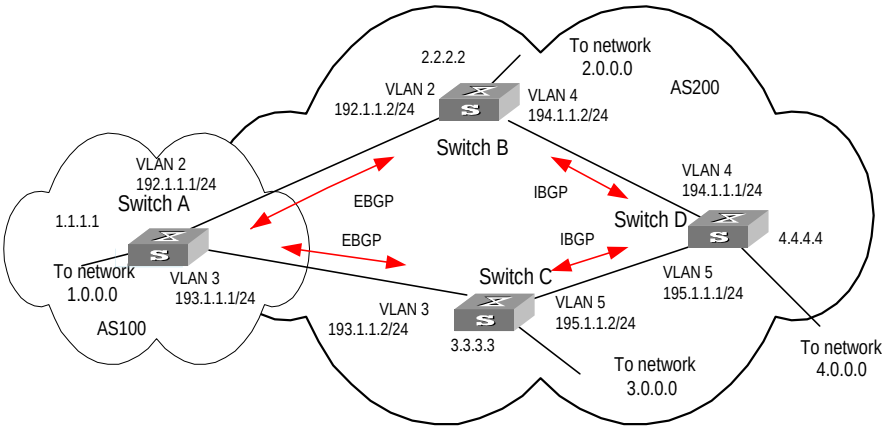
Using the **display bgp routing-table** command, you can view BGP routing table on Switch B. Note that Switch B knows of the existence of network 1.0.0.0.

Using the **display bgp routing-table** command, you can view the BGP routing table on Switch D. Note that Switch D also knows the existence of network 1.0.0.0.

Configuring BGP Routing

This example illustrates how the administrators manage the routing via BGP attributes. All switches are configured with BGP, and IGP in AS 200 uses OSPF. Switch A is in AS 100, and acts as Switch B of AS 200 and BGP neighbor of Switch C. Both Switch B and Switch C operate IBGP to Switch D. Switch D is also in AS 200.

Figure 15 BGP Routing Configuration



1 Configure Switch A:

```
[Switch A]interface Vlan-interface 2
[Switch A-Vlan-interface2]ip address 192.1.1.1 255.255.255.0
[Switch A]interface Vlan-interface 3
[Switch A-Vlan-interface3]ip address 193.1.1.1 255.255.255.0
```

a Enable BGP

```
[Switch A]bgp 100
```

b Specify the network that BGP sends to

```
[Switch A-bgp]network 1.0.0.0
```

c Configure the peers

```
[Switch A-bgp]group ex192 external
[Switch A-bgp]peer 192.1.1.2 group ex192 as-number 200
[Switch A-bgp]group ex193 external
[Switch A-bgp]peer 193.1.1.2 group ex193 as-number 200
[Switch A-bgp]quit
```

d Configure the MED attribute of Switch A

- Add ACL on Switch A, enable network 1.0.0.0.

```
[Switch A]acl number 2000
[Switch A-acl-basic-2000]rule permit source 1.0.0.0 0.255.255.255
```

- Define two route policies, one is called apply_med_50 and the other is called apply_med_100. The first MED attribute with the route policy as network 1.0.0.0 is set as 50, while the MED attribute of the second is 100.

```
[Switch A]route-policy apply_med_50 permit node 10
[Switch A-route-policy]if-match acl 2000
[Switch A-route-policy]apply cost 50
[Switch A-route-policy]quit
[Switch A]route-policy apply_med_100 permit node 10
[Switch A-route-policy]if-match acl 2000
[Switch A-route-policy]apply cost 100
[Switch A-route-policy]quit
```

- Apply route policy set_med_50 to egress route update of Switch C (193.1.1.2), and apply route policy set_med_100 on the egress route of Switch B (192.1.1.2)

```
[Switch A]bgp 100
[Switch A-bgp]peer ex193 route-policy apply_med_50 export
[Switch A-bgp]peer ex192 route-policy apply_med_100 export
```

2 Configure Switch B:

```
[Switch B]interface vlan-interface 2
[Switch B-Vlan-interface2]ip address 192.1.1.2 255.255.255.0
[Switch B]interface vlan-interface 4
[Switch B-Vlan-interface4]ip address 194.1.1.2 255.255.255.0
[Switch B]ospf
[Switch B-ospf-1]area 0
[Switch B-ospf-1-area-0.0.0.0]network 194.1.1.0 0.0.0.255
[Switch B-ospf-1-area-0.0.0.0]network 192.1.1.0 0.0.0.255
[Switch B]bgp 200
[Switch B-bgp]undo synchronization
[Switch B-bgp]group ex external
[Switch B-bgp]peer 192.1.1.1 group ex as-number 100
[Switch B-bgp]group in internal
[Switch B-bgp]peer 194.1.1.1 group in
```

3 Configure Switch C:

```
[Switch C]interface Vlan-interface 3
[Switch C-Vlan-interface3]ip address 193.1.1.2 255.255.255.0
[Switch C]interface vlan-interface 5
[Switch C-Vlan-interface5]ip address 195.1.1.2 255.255.255.0
[Switch C]ospf
```

```
[Switch C-ospf-1]area 0
[Switch C-ospf-1-area-0.0.0.0]network 193.1.1.0 0.0.0.255
[Switch C-ospf-1-area-0.0.0.0]network 195.1.1.0 0.0.0.255
[Switch C]bgp 200
[Switch C-bgp]group ex external
[Switch C-bgp]peer 193.1.1.1 group ex as-number 100
[Switch C-bgp]group in internal
[Switch C-bgp]peer 195.1.1.1 group in
```

4 Configure Switch D:

```
[Switch D]interface vlan-interface 4
[Switch D-Vlan-interface4]ip address 194.1.1.1 255.255.255.0
[Switch D]interface vlan-interface 5
[Switch D-Vlan-interface5]ip address 195.1.1.1 255.255.255.0
[Switch D]ospf
[Switch D-ospf-1]area 0
[Switch D-ospf-1-area-0.0.0.0]network 194.1.1.0 0.0.0.255
[Switch D-ospf-1-area-0.0.0.0]network 195.1.1.0 0.0.0.255
[Switch D-ospf-1-area-0.0.0.0]network 4.0.0.0 0.255.255.255
[Switch D]bgp 200
[Switch D-bgp]group ex external
[Switch D-bgp]peer ex as-number 200
[Switch D-bgp]peer 195.1.1.2 group ex
[Switch D-bgp]peer 194.1.1.2 group ex
```

To enable the configuration, all BGP neighbors will be reset using **reset bgp all** command.

After above configuration, due to the fact that the MED attribute of route 1.0.0.0 discovered by Switch C is less than that of Switch B, Switch D will first select the route 1.0.0.0 from Switch C.

If the MED attribute of Switch A is not configured, the local preference on Switch C is configured as follows:

1 Add ACL 2000 on Switch C and permit network 1.0.0.0

```
[Switch C]acl number 2000
[Switch C-acl-basic-2000]rule permit source 1.0.0.0 0.255.255.255
```

2 Define the route policy with the name of localpref, of those, the local preference matching ACL 2000 is set as 200, and that of not matching is set as 100:

```
[Switch C]route-policy localpref permit node 10
[Switch C-route-policy]if-match acl 2000
[Switch C-route-policy]apply local-preference 200
[Switch C-route-policy]route-policy localpref permit node 20
[Switch C-route-policy]apply local-preference 100
[Switch C-route-policy]quit
```

3 Apply such route policy to the BGP neighbor 193.1.1.1 (Switch A)

```
[Switch C]bgp 200
[Switch C-bgp]peer 193.1.1.1 route-policy localpref import
```

By then, due to the fact that the Local preference attribute value (200)of the route 1.0.0.0 learned by Switch C is more than that of Switch B (Switch B is not configured with local Preference attribute, 100 by default), Switch D will also first select the route 1.0.0.0 from Switch C.

Troubleshooting BGP

The neighborhood cannot be established (the established state cannot be entered).

The establishment of a BGP neighborhood requires that the router be able to establish a TCP connection through port 179 and exchanges open packets correctly. Do the following:

- Check whether the configuration of the neighbor's AS number is correct.
- Check whether the neighbor's IP address is correct.
- If the loopback interface is not being used, check whether the **connect-source loopback** has been configured. By default, the router uses the optimal local interface to establish the TCP connection, not using the loopback interface.
- If the EBGP neighbor is not directly connected, check whether the **peer ebgp-max-hop** has been configured.
- Use the **ping** command to check whether the TCP connection is normal. Since one router may have several interfaces able to reach the peer, the extended **ping -a** *ip-address* command should be used to specify the source IP address sending ping packet.
- If the ping operation fails, use the **display ip routing-table** command to check if there is available route in the routing table to the neighbor.

If the ping operation succeeds, check if there is an ACL denying TCP port 179. If the ACL is configured, cancel the denying of port 179.

The BGP route cannot be advertised correctly after importing route of IGP with the command network.

Do the following:

The route that is imported by a command network should be same as a route in the current routing table, and should include a destination segment and mask. A route that covers a large network segment cannot be imported. For example, route 10.1.1.0/24 can be imported, while 10.0.0.0/8 may cause an error.

IP Routing Policy

When a router distributes or receives routing information, it needs to implement some policies to filter the routing information so it can receive or distribute the routing information that meets only the specified condition. A routing protocol such as RIP may need to import routing information discovered by other protocols to enrich its routing knowledge. While importing the routing information, it must import only the information that meets its conditions.

To implement the routing policy, you must define a set of rules by specifying the characteristics of the routing information to be filtered. You can set the rules based on such attributes as destination address and source address of the information. The rules can be set in advance and then used in the routing policy to advertise, receive, and import the route information.

Configuring IP Routing Policy is described in the following sections:

- Routing Information Filters
- Configuring an IP Routing Policy

- Troubleshooting Routing Policies
- Limiting Route Capacity
- Configuring Route Capacity

Routing Information Filters

The Switch 8800 supports four kinds of filters, route-policy, acl, ip-prefix, and community-list. The following sections introduce these filters:

- Route Policy
- ACL
- IP Prefix
- Community List

Route Policy

A route map is used for matching some attributes with given routing information and the attributes of the information will be set if the conditions are satisfied.

A route map can include multiple nodes. Each node is a unit for match testing, and the nodes are matched in a sequence-number-based order. Each node includes a set of **if-match** and **apply** clauses. The **if-match** clauses define the matching rules and the matching objects are attributes of routing information. The comparison of **if-match** clauses for a node uses a series of Boolean *and* statements. As a result, a match is found if all the matching conditions specified by the **if-match** clauses are satisfied. The **apply** clause specifies the actions that are performed after the node match test concerning the attribute settings of the route information.

The comparison of different nodes in a route policy uses a Boolean *or* statement. The system examines the nodes in the route policy in sequence. Once the route is permitted by a single node in the route policy, the route passes the matching test of the route policy without attempting the test of the next node.

ACL

The access control list (ACL) used by the route policy can be divided into three types: advanced ACL, basic ACL, and Layer-2 ACL.

A basic ACL is usually used for routing information filtering. When the user defines the ACL, the user defines the range of an IP address, subnet for the destination network segment address, or the next-hop address of the routing information. If an advanced ACL is used, perform the matching operation by the specified source address range. Layer-2 ACLs

IP Prefix

The function of the ip-prefix is similar to that of the acl, but it is more flexible and easier for users to understand. When the ip-prefix is applied to routing information filtering, its matching objects are the destination address information, and the domain of the routing information. In addition, in the ip-prefix, you can specify the **gateway** options and require it to receive only the routing information distributed by certain routers.

An ip-prefix is identified by the ip-prefix name. Each ip-prefix can include multiple list items, and each list item can specify the match range of the network prefix forms, and is identified with a index-number. The index-number designates the matching check sequence in the ip-prefix.

During the matching, the router checks list items identified by the sequence-number in ascending order. Once a single list item meets the condition, it means that it has passed the ip-prefix filtering and does not enter the testing of the next list item.

Community List

The community list is only used in BGP. The routing information packet of BGP includes a community attribute domain to identify a community. The community list specifies the match condition target for the community attribute.

The definition of the community list is already implemented in the BGP configuration.

Configuring an IP Routing Policy

Configuring a routing policy includes tasks described in the following sections:

- Defining a Route Policy
- Defining If-match Clauses for a Route Policy
- Defining Apply Clauses for a Route Policy
- Importing Routing Information Discovered by Other Routing Protocols
- Defining IP Prefix
- Configuring for Filtering Received Routes
- Configuring for Filtering Distributed Routes
- Displaying and Debugging the Routing Policy

Defining a Route Policy

A route policy can include multiple nodes. Each node is a unit for the matching operation. The nodes are tested again by *sequence-number*.

Perform the following configurations in system view.

Table 132 Defining a Route Policy

Operation	Command
Enter Route policy view	**route-policy** *route-policy-name* { **permit | deny** } **node** { *node-number* }
Remove the specified route-policy	**undo route-policy** *route-policy-name* [**permit** | **deny** | **node** *node-number*]

The **permit** argument specifies that if a route satisfies all the **if-match** clauses of a node, the route passes the filtering of the node, and the **apply** clauses for the node are executed without taking the test of the next node. If a route does not satisfy all the if-match clauses of a node, however, the route takes the test of the next node.

The **deny** argument specifies that the **apply** clauses are not executed. If a route satisfies all the **if-match** clauses of the node, the node denies the route and the

route does not take the test of the next node. If a route does not satisfy all the **if-match** clauses of the node, however, the route takes the test of the next node.

The router tests the route against the nodes in the route policy in sequence, once a node is matched, the route policy filtering is passed.

By default, the route policy is not defined.

*If multiple nodes are defined in a route policy, at least one of them should be in **permit** mode. Apply the route policy to filter routing information. If the routing information does not match any node, the route policy denies the routing information. If all the nodes in the route policy are in deny mode, all routing information will be denied by the route policy.*

Defining If-match Clauses for a Route Policy

The **if-match** clauses define the matching rules that the routing information must satisfy to pass the route policy. The matching objects are attributes of the routing information.

Perform the following configurations in route policy view.

Table 133 Defining If-match Conditions

Operation	Command
Match the AS path domain of the BGP routing information	**if-match as-path** *acl-number*
Cancel the matched AS path domain of the BGP routing information	**undo if-match as-path**
Match the community attribute of the BGP routing information	**if-match community** { *standard-community-number* [**whole-match**] **|** *extended-community-number* }
Cancel the matched community attribute of the BGP routing information	**undo if-match community**
Match the destination address of the routing information	**if-match** { **acl** | **ip-prefix** }
Cancel the matched destination address of the routing information set by the ACL	**undo if-match** [**acl** *acl-number* | **ip-prefix** *ip-prefix-name*]
Match the next-hop interface of the routing information	**if-match interface** { *interface-type interface-number* }
Cancel the matched next-hop interface of the routing information	**undo if-match interface**
Match the next-hop of the routing information	**if-match ip next-hop** { **acl** *acl-number* | **ip-prefix** *ip-prefix-name* }
Cancel the matched next-hop of the routing information set by the address prefix list	**undo if-match ip next-hop** [**ip-prefix** *ip-prefix-name*]
Match the routing cost of the routing information	**if-match cost** *cost*
Cancel the matched routing cost of the routing information	**undo if-match cost**
Match the tag domain of the OSPF routing information	**if-match tag** *value*
Cancel the tag domain of the matched OSPF routing information	**undo if-match tag**

By default, no matching is performed.

*The **if-match** clauses for a node in the route policy require that the route satisfy all the clauses to match the node before the actions specified by the **apply** clauses can be executed.*

*If no **if-match** clauses are specified, all the routes pass the filtering on the node.*

Defining Apply Clauses for a Route Policy

The **apply** clauses specify actions, which are the configuration commands executed after a route satisfies the filtering conditions that are specified in the **if-match** clauses. In this way, some attributes of the route can be modified.

Perform the following configurations in Route policy view.

Table 134 Defining Apply Clauses

Operation	Command
Modify an AS path for BGP routes.	**apply as-path** *as-number-1* [*as-number-2* [*as-number-3* ...]]
Cancel modification of an AS path for BGP routes.	**undo apply as-path**
Set the community attribute in the BGP routing information	**apply community** { [{ *aa:nn* | **no-export-subconfed** | **no-advertise** | **no-export**]... } | [**additive** | **none**]
Cancel the set community attribute in the BGP routing information	**undo apply community**
Set the next-hop address of the routing information	**apply ip next-hop** { *ip-address* [*ip-address*] | **acl** *acl-number* }
Cancel the next-hop address of the routing information	**undo apply ip next-hop**
Import the route to IS-IS Level 1, Level 2, or Level 1-2	**apply isis** [**level-1** | **level-2** | **level-1-2**]
Remove the function of importing the route to IS-IS	**undo apply isis**
Set the local preference of the BGP routing information	**apply local-preference** *localpref*
Cancel the local preference of the BGP routing information	**undo apply local-preference**
Set the routing cost of the routing information	**apply cost** *value*
Cancel the routing cost of the routing information	**undo apply cost**
Set the cost type of the routing information	**apply cost-type** [**internal** | **external**]
Remove the setting of the cost type	**undo apply cost-type**
Set the route origin of the BGP routing information	**apply origin** { **igp** | **egp** *as-number* | **incomplete** }
Cancel the route origin of the BGP routing information	**undo apply origin**
Set the tag domain of the OSPF routing information	**apply tag** *value*
Cancel the tag domain of the OSPF routing information	**undo apply tag**

By default, no apply clauses are defined.

If the routing information meets the match conditions specified in the route policy and also notifies the MED value configured with **apply cost-type internal** when notifying the IGP route to the EBGP peers, then this value is regarded as the MED value of the IGP route. The preference configured with the **apply cost-type internal** is lower than the preference that is configured with the **apply cost** command, but higher than the preference that is configured with the **default med** command.

Importing Routing Information Discovered by Other Routing Protocols

A routing protocol can import the routes that are discovered by other routing protocols to enrich its route information. The route policy can filter route information to implement the redistribution. If the destination routing protocol that imports the routes cannot directly reference the route costs of the source routing protocol, you should satisfy the requirement of the destination protocol by specifying a route cost for the imported route.

Perform the following configuration in routing protocol view.

Table 135 Configuring Importing Routes of Other Protocols

Operation	Command
Import routes of other protocols	**import-route** *protocol* [**med** *med* | **cost** *cost*] [**tag** *value*] [**type 1** | **2**] [**route-policy** *route-policy-name*]
Do not import routes of other protocols	**undo import-route** *protocol*

By default, the routes discovered by other protocols are not imported.

*In different routing protocol views, the parameter options are different. For details, refer to the description of the **import-route** command for each protocol .*

Defining IP Prefix

A prefix list is identified by the IP prefix name. Each IP prefix can include multiple items, and each item can specify the matching range of the network prefix forms. The *index-number* specifies the matching sequence in the prefix list.

Perform the following configurations in system view.

Table 136 Defining Prefix-list

Operation	Command
Define a prefix list	**ip ip-prefix** *ip-prefix-name* [**index** *index-number*] { **permit | deny** } *network len* [**greater-equal** *greater-equal*] [**less-equal** *less-equal*]
Remove a prefix list	**undo ip ip-prefix** *ip-prefix-name* [**index** *index-number* | **permit** | **deny**]

During the matching, the router checks list items identified by the *index-number* in the ascending order. If only one list item meets the condition, it means that it has passed the **ip-prefix** filtering (and does not enter the testing of the next list item).

If more than one IP prefix item is defined, then the match mode of at least one list item should be the **permit** mode. The list items of the **deny** mode can be defined to rapidly filter the routing information not satisfying the requirement, but if all

the items are in the **deny** mode, no route will pass the **ip-prefix** filtering. You can define an item of **permit** 0.0.0.0/0 **greater-equal** 0 **less-equal** 32 after the multiple list items in the **deny** mode to let all the other routes pass.

Configuring for Filtering Received Routes

Perform the following configuration in routing protocol view.

Define a policy that filters the routing information that does not satisfy the conditions and receives routes with the help of an ACL or address prefix-list. The **filter-policy gateway** command specifies that only the update packets from a specific neighboring router will be received.

Table 137 Configuring Filtering for Received Routes

Operation	Command
Configure to filter the received routing information distributed by the specified address	**filter-policy gateway** *ip-prefix-name* **import**
Cancel the filtering of the received routing information distributed by the specified address	**undo filter-policy gateway** *ip-prefix-name* **import**
Configure to filter the received global routing information	**filter-policy** { *acl-number* | **ip-prefix** *ip-prefix-name* } [**gateway] import**
Cancel the filtering of the received global routing information	**undo filter-policy** { *acl-number* | **ip-prefix** *ip-prefix-name* } [**gateway**] **import**

Configuring for Filtering Distributed Routes

Define a policy concerning route distribution that filters the routing information that does not satisfy the conditions, and distributes routes with the help of an ACL or address ip-prefix.

Perform the following configuration in routing protocol view.

Table 138 Configuring Filtering of Distributed Routes

Operation	Command
Configure to filter the routes distributed by the protocol	**filter-policy** { *acl-number* | **ip-prefix** *ip-prefix-name* } **export** [*routing-process*]
Cancel the filtering of the routes distributed by the protocol	**undo filter-policy** { *acl-number* | **ip-prefix** *ip-prefix-name* } **export** [*routing-process*]

The route policy supports importing the routes discovered by the following protocols into the routing table:

- Direct: The hop (or host) to which the local interface is directly connected.
- Static: Static Route Configuration
- RIP: Route discovered by RIP
- OSPF: Route discovered by OSPF
- OSPF-ASE: External route discovered by OSPF
- OSPF-NSSA: NSSA route discovered by OSPF
- BGP: Route acquired by BGP

If routing-process is BGP, you should also specify the process number or AS number.

By default, the filtering of the received and distributed routes will not be performed.

Displaying and Debugging the Routing Policy

Execute **display** command in all views to display the operation of the routing policy configuration, and to verify the effect of the configuration.

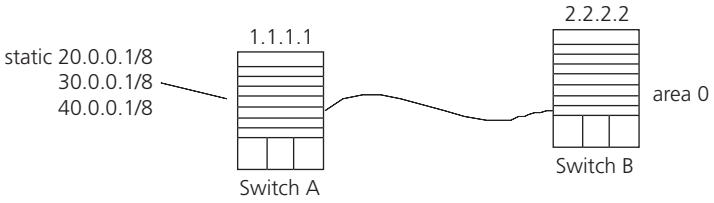
Table 139 Displaying and Debugging the Route Policy

Operation	Command
Display the routing policy	**display route-policy** [*route-policy-name*]
Display the path information of the AS filter in BGP	**display ip as-path-acl** [*acl-number*]
Display the address prefix list information	**display ip ip-prefix** [*ip-prefix-name*]

Example: Configuring to Filter the Received Routing Information

- Switch A communicates with Switch B, running the OSPF protocol.
- Redistribute three static routes through configuring the OSPF routing process on the Switch A.
- The route filtering rules can be configured on Switch B to make the received three static routes partially visible and partially shielded. It means that routes in the network segments 20.0.0.0 and 40.0.0.0 are visible while those in the network segment 30.0.0.0 are shielded.

Figure 16 Filtering Received Routing Information



Configure Switch A:

1 Configure the IP address of VLAN interface.

```
[Switch A]interface vlan-interface 100
[Switch A-Vlan-interface100]ip address 10.0.0.1 255.0.0.0
[Switch A]interface vlan-interface 200
[Switch A-Vlan-interface200]ip address 12.0.0.1 255.0.0.0
```

2 Configure three static routes.

```
[Switch A]ip route-static 20.0.0.1 255.255.255.255 12.0.0.1
[Switch A]ip route-static 30.0.0.1 255.255.255.255 12.0.0.1
[Switch A]ip route-static 40.0.0.1 255.255.255.255 12.0.0.1
```

3 Enable OSPF protocol and specifies the number of the area to which the interface belongs.

```
[Switch A]router id 1.1.1.1
[Switch A]ospf
[Switch A-ospf]area 0
[Switch A-ospf-area-0.0.0.0]network 10.0.0.0 0.0.0.255
```

4 Import the static routes

```
[Switch A-ospf]import-route static
```

Configure Switch B:

1 Configure the IP address of VLAN interface.

```
[Switch B]interface vlan-interface 100
[Switch B-Vlan-interface100]ip address 10.0.0.2 255.0.0.0
```

2 Configure the access control list.

```
[Switch B]acl number 2000
[Switch B-acl-basic-2000]rule deny source 30.0.0.0 0.255.255.255
[Switch B-acl-basic-2000]rule permit source any
```

3 Enable OSPF protocol and specifies the number of the area to which the interface belongs.

```
[Switch B]router id 2.2.2.2
[Switch B]ospf
[Switch B-ospf]area 0
[Switch B-ospf-area-0.0.0.0]network 10.0.0.0 0.0.0.255
```

4 Configure OSPF to filter the external routes received.

```
[Switch B-ospf]filter-policy 2000 import
```

Troubleshooting Routing Policies

Routing information filtering cannot be implemented in normal operation of the routing protocol

Check for the following faults:

- The if-match mode of at least one node of the Route policy should be the **permit** mode. When a Route-policy is used for the routing information filtering, if a piece of routing information does not pass the filtering of any node, then it means that the route information does not pass the filtering of the Route-policy. When all the nodes of the Route-policy are in the **deny** mode, then all the routing information cannot pass the filtering of the Route-policy.
- The if-match mode of at least one list item of the ip-prefix should be the **permit** mode. The list items of the **deny** mode can be defined to rapidly filter the routing information not satisfying the requirement, but if all the items are in the deny mode, no routes will pass the ip-prefix filtering. You can define an item of permit 0.0.0.0/0 less-equal 32 after the multiple list items in the deny mode, so as to let all the other routes pass the filtering (If less-equal 32 is not specified, only the default route will be matched).

Route Capacity

In practical networking applications, there is always a large number of routes in the routing table, especially OSPF routes and BGP routes. The routing information is usually stored in the memory of the switch. When the size of the routing table increases, it can consume a significant amount of switch's memory.

To solve this problem, Switch 8800 switches provide a mechanism to control the size of the routing table. They monitor the free memory in the system to determine whether to add new routes to the routing table, and whether or not to keep connection with a routing protocol.

The default value normally meets the network requirements. You should be careful when modifying the configuration to avoid reducing the stability of the network.

Limiting Route Capacity

The size of the routing table is determined by BGP and OSPF routes. Therefore, the route capacity limitation of the Switch 8800 is only effective for these two types of routes and has no impact on static routes and other dynamic routing protocols.

When the free memory of a Switch 8800 reduces to the lower limit value, the system will disconnect BGP and OSPF and remove their routes from the routing table to release memory. The system checks the free memory periodically. When enough free memory is detected to restore the safety value, BGP and OSPF connection is restored.

Configuring Route Capacity

Route capacity configuration includes tasks described in the following sections:

- Setting the Lower Limit and the Safety Value Simultaneously
- Enabling and Preventing Automatic Recovery of Disconnected Routing Protocols
- Displaying and Debugging Route Capacity

Setting the Lower Limit and the Safety Value Simultaneously

When you need to modify both the lower limit and the safety value of the switch memory, you can (and are recommended to) simultaneously modify the two configurations.

You can also restore the lower limit and the safety value of the switch memory to the default value at the same time if it is necessary.

Perform the following configuration in the system view.

Table 140 Setting the Lower Limit and the Safety Value of the Switch Memory Simultaneously

Operation	Command
Set the lower limit and the safety value of the switch memory simultaneously	**memory safety** *safety-value* **limit** *limit-value*
Restore the lower limit and the safety value of the switch memory to the default value	**undo memory [safety** | limit]

The default values of the lower limit and the safety value of the switch memory are 2Mbytes and 4Mbytes, respectively.

Note that *safety-value* must have a higher value than *limit-value*.

Enabling and Preventing Automatic Recovery of Disconnected Routing Protocols

If the automatic memory restoration function of a switch is disabled, connection of routing protocols will not be restored even if the free memory returns to the safety value.

Perform the following configurations in system view.

Table 141 Enabling and Preventing Automatic Recovery of Disconnected Routing Protocols

Operation	Command
Enable automatic recovery of disconnected routing protocols	**memory auto-establish enable**
Prevent automatic recovery of disconnected routing protocols	**memory auto-establish disable**

By default, memory automatic restoration function of a switch is enabled.

Displaying and Debugging Route Capacity

Execute the **display** command in all views to display the route capacity configuration.

Table 142 Displaying and Debugging Route Capacity

Operation	Command
Display the route capacity related memory information	**display memory** [**slot** *slot-number*]
Display the route capacity related memory setting and state information	**display memory limit**

6 MULTICAST PROTOCOL

This chapter includes information on the following:

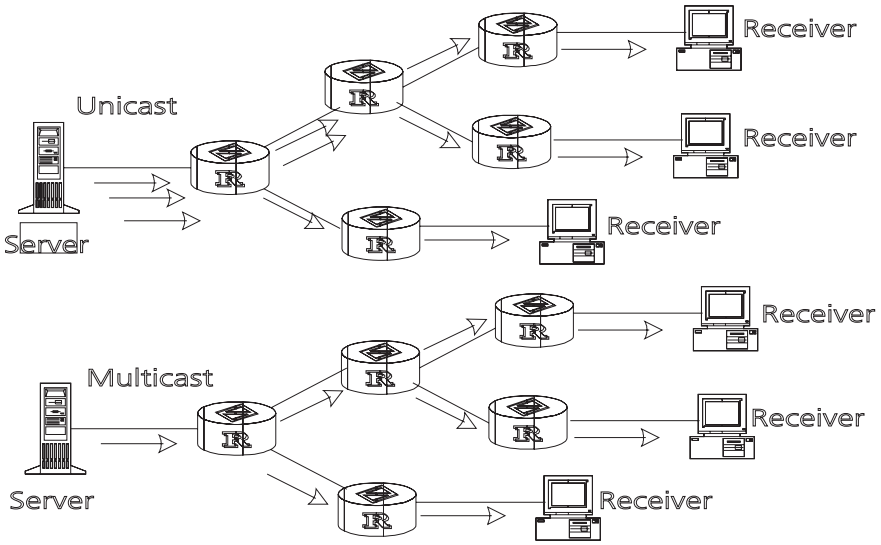
- IP Multicast Overview
- Configuring Common Multicast
- Configuring IGMP
- IGMP Snooping
- Configuring PIM-DM
- Configuring PIM-SM
- GMRP

IP Multicast Overview

Many transmission methods can be used when the destination (including data, voice and video) is the secondary use of the network. If the multicast method is used, you should establish an independent data transmission path for each user. The broadcast mode can be used if you intend to send the information to all users on the network. In either case, the end users will receive the information. For example, if the same information is required by 200 users on the network, the traditional solution is to send the information 200 times in unicast mode. In the broadcast mode, the data is broadcast over the entire network. However, both of the methods waste bandwidth resources. In addition, the broadcast mode cannot ensure information security.

IP multicast technology solves this problem. The multicast source sends the information only once. Multicast routing protocols establish tree-type routing for multicast packets. The information being sent will be replicated and distributed as far as possible (see Figure 1). Therefore, the information can be correctly sent, with high efficiency, to each user.

Figure 1 Comparison Between the Unicast and Multicast Transmission



A multicast source does not necessarily belong to a multicast group. It only sends data to the multicast group and it is not necessarily a receiver. Multiple sources can send packets to a multicast group simultaneously.

A router that does not support multicast may exist on the network. A multicast router can encapsulate multicast packets in unicast IP packets by tunneling and sending them on to the neighboring multicast router. The neighboring multicast router removes the unicast IP header and continues the multicast transmission.

Multicast advantages:

- Enhanced efficiency by reducing network traffic and relieving server and CPU loads.
- Optimized performance decreases traffic redundancy.
- Distributed applications make multipoint applications possible.

Configuring an IP Multicast Overview is described in the following sections:

- Multicast Addresses
- IP Multicast Protocols
- Forwarding IP Multicast Packets
- Applying Multicast

Multicast Addresses

The destination addresses of multicast packets use Class D IP addresses ranging from 224.0.0.0 to 239.255.255.255. Class D addresses cannot appear in the source IP address fields of IP packets.

During unicast data transmission, a packet is transmitted from the source address to the destination address with the "hop-by-hop" principle of the IP network. A packet has more than one destination address in a multi-cast environment, i.e., a group of addresses. All the information receivers join a group. Once a receiver joins the group, data flowing to the group is sent to the receiver immediately. All members in the group can receive the packets. Membership of a multicast group is dynamic, that is, hosts can join and leave groups at any time.

A multicast group can be either permanent or temporary. Part of addresses in the multicast group are reserved by the IANA and are known as the permanent multicast group. IP addresses of a permanent group are unchanged, but the members in the group can change. The number of members in a permanent multicast group can be random or even 0. Those IP multicast addresses that are not reserved for permanent multicast groups can be used by temporary groups.

Ranges and meanings of Class D addresses are shown in Table 1.

Table 1 Ranges and Meanings of Class D Addresses

Class D address range	Meaning
224.0.0.0~224.0.0.255	Reserved multicast addresses (addresses of permanent groups). Address 224.0.0.0 is reserved. The other addresses can be used by routing protocols.
224.0.1.0~238.255.255.255	Multicast addresses available for users (addresses of temporary groups). They are valid in the entire network.
239.0.0.0~239.255.255.255	Multicast addresses for local management. They are valid only in the specified local range.

Reserved multicast addresses that are commonly used are shown Table 2:

Table 2 Reserved Multicast Address List

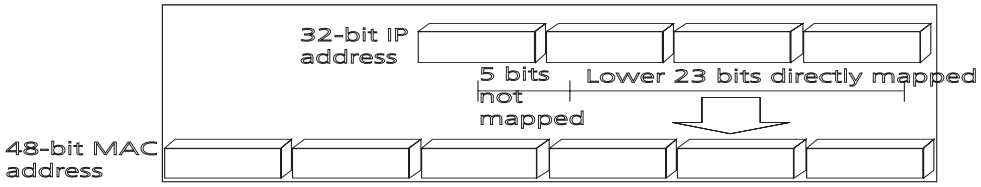
Class D address	Meaning
224.0.0.0	Base Address (Reserved)
224.0.0.1	Addresses of all hosts
224.0.0.2	Addresses of all multicast routers
224.0.0.3	Unassigned
224.0.0.4	DVMRP routers
224.0.0.5	OSPF routers
224.0.0.6	OSPF DR (designated router)
224.0.0.7	ST routers
224.0.0.8	ST hosts
224.0.0.9	RIP-2 routers
224.0.0.10	IGRP routers
224.0.0.11	Mobile agents
224.0.0.12	DHCP server/Relay agent
224.0.0.13	All PIM routers
224.0.0.14	RSVP encapsulation
224.0.0.15	All CBT routers
224.0.0.16	Designated SBM
224.0.0.17	All SBMS
224.0.0.18	VRRP
……	……

Ethernet Multicast MAC Addresses

When unicast IP packets are transmitted in Ethernet, the destination MAC address is the MAC address of the receiver. However, when multicast packets are

transmitted, the destination is no longer a specific receiver but a group with unspecific members. Therefore, the multicast MAC address should be used. Multicast MAC addresses correspond to multicast IP addresses. IANA (Internet Assigned Number Authority) stipulates that the higher 24 bits of the multicast MAC address is 0x01005e and the lower 23 bits of the MAC address is the lower 23 bits of the multicast IP address.

Figure 2 Mapping Between the Multicast IP Address and the Ethernet MAC Address



Only 23 bits of the last 28 bits in the IP multicast address is mapped to the MAC address. Therefore the 32 IP multicast addresses are mapped to the same MAC address.

IP Multicast Protocols

Multicast uses the multicast group management protocol, and the multicast routing protocol. The multicast group management protocol uses Internet Group Management Protocol (IGMP) as the IP multicast basic signaling protocol. It is used between hosts and routers and enables routers to determine if members of the multicast group are on the network segment. The multicast routing protocol is used between multicast routers and creates and maintains multicast routes, and allows high-efficient multicast packet forwarding. At present, multicast routing protocols mainly include PIM-SM, PIM-DM.

Tasks for configuring IP Multicast Protocols are described in the following sections:

- Internet Group Management Protocol (IGMP)
- Multicast Routing Protocol

Internet Group Management Protocol (IGMP)

Internet Group Management Protocol (IGMP) is the only protocol that hosts can use. It defines the membership establishment and maintenance mechanism between hosts and routers, and is the basis of the entire IP multicast. Hosts report the group membership to a router through IGMP and inform the router of the conditions of other members in the group through the directly connected host.

If a user on the network joins a multicast group through IGMP declaration, the multicast router on the network will transmit the information sent to the multicast group through the multicast routing protocol. Finally, the network will be added to the multicast tree as a branch. When the host, as a member of a multicast group, begins receiving the information, the router queries the group periodically to check whether members in the group are involved. As long as one host is involved, the router receives data. When all users on the network quit the multicast group, the related branches are removed from the multicast tree.

Multicast Routing Protocol

A multicast group address has a virtual address. Unicast allows packets to be routed from the data source to the specified destination address. This is not

possible for multicast. The multicast application sends the packets to a group of receivers (as with multicast addresses) who are ready to receive the data but not only to one receiver (as with unicast address).

The multicast routing creates a loop-free data transmission path from one data source to multiple receivers. The task of the multicast routing protocol is to create a distribution tree architecture. A multicast router can use multiple methods to build up a path for data transmission, i.e., the distribution tree.

- PIM-DM (Protocol-Independent Multicast Dense Mode, PIM-DM)

  PIM dense mode is suitable for small networks. It assumes that each subnet in the network contains at least one receiver who is interested in the multicast source. Multicast packets are flooded to all points of the network. Subsequent resources (such as bandwidth and CPU of routers) are consumed. In order to decrease the consumption of these precious network resources, branches that do not have members send Prune messages toward the source to reduce the unwanted/unnecessary traffic. To enable the receivers to receive multicast data streams, the pruned branches can be restored periodically to a forwarding state. To reduce latency time, the PIM dense mode uses the prune mechanism to actively restore multicast packet forwarding. The periodical flood and prune are characteristics of PIM dense mode. Generally, the forwarding path in dense mode is a "source tree" rooted at the source with multicast members as the branches. Since the source tree uses the shortest path from the multicast source and the receiver, it is also called the shortest path tree (SPT).

- PIM-SM (Protocol-Independent Multicast Sparse Mode, PIM-SM)

  Dense mode uses the flood-prune technology, which is not applicable for WAN. In WAN, multicast receivers are sparse and therefore the sparse mode is used. In sparse mode, hosts need not receive multicast packets unless, by default, there is an explicit request for the packets. A multicast router must send a join message to the RP (Rendez-vous Point, which needs to be built into the network and is a virtual place for data exchange) corresponding to the group for receiving the multicast data traffic from the specified group. The join message passes routers and finally reaches the root, i.e., the RP. The join message becomes a branch of the shared tree. In PIM sparse mode, multicast packets are sent to the RP first, and then are forwarded along the shared tree rooted at the RP and with members as the branches. To prevent the branches of the shared tree from being deleted, PIM sparse mode sends join messages to branches periodically to maintain the multicast distribution tree.

  To send data to the specified address, senders register with the RP first before forwarding data to the RP. When the data reaches the RP, the multicast packets are replicated and sent to receivers along the path of the distribution tree. Replication only happens at the branches of the distribution tree. This process can be repeated automatically until the packets reach the destination.

Forwarding IP Multicast Packets

In the multicast model, the source host sends information to the host group represented by the multicast group address within the destination address fields of the IP packets. The multicast model must forward multicast packets to multiple external interfaces so that the packets can be forwarded to all receivers.

- RPF (Reverse Path Forwarding)

  To ensure that a multicast packet reaches the router along the shortest path, the multicast must depend on the unicast routing table or a unicast routing

table independently provided for multicast (such as the MBGP multicast routing table). This check mechanism is the basis for most multicast routing protocols , which is known as a RPF (Reverse Path Forwarding) check. A multicast router uses the source address from the multicast packet to query the unicast routing table, or the independent multicast routing table, to determine the incoming interface at which the packet arrives. If a source tree is used, the source address is the address of the source host sending the multicast packet. If a shared tree is used, the source address is the address of the root of the shared tree. When a multicast packet arrives at the router, if RPF check succeeds, the packet will be forwarded according to the multicast forwarding entry. Otherwise, the packet will be dropped.

Applying Multicast

IP multicast technology effectively solves the problem of packet forwarding from single-point to multi-point. It implements high-efficient data transmission from single-point to multi-point in IP networks and can save a large amount of network bandwidth and reduce network loads. New value-added services that use multicast can be delivered, including direct broadcasting, Web TV, distance learning, distance medicine, net broadcasting station and real-time audio/video conferencing.

- Multimedia and streaming media applications
- Communications of the training and corporate sites
- Data repository and finance (stock) applications
- Any "point-to-multi-point" data distribution

With the increase of multimedia services on IP networks, multicast has huge market potential.

Configuring Common Multicast

A common multicast configuration covers both the multicast group management protocol and the multicast routing protocol. The configuration includes enabling multicast, configuring multicast forwarding boundary, and displaying multicast routing table and multicast forwarding table.

Configuring Common Multicast

Common multicast configuration includes:

- Enabling Multicast
- Configuring the Multicast Route Limit
- Clearing MFC Forwarding Entries or Statistic Information
- Clearing Route Entries From the Core Multicast Routing Table
- Displaying and Debugging Common Multicast Configuration

Enabling Multicast

Enable multicast first before enabling the multicast routing protocol.

Perform the following configuration in system view.

Table 3 Enabling Multicast

Operation	Command
Enable multicast	**multicast routing-enable**

Table 3 Enabling Multicast

Operation	Command
Disable multicast	**undo multicast routing-enable**

By default, multicast routing is disabled.

Only when multicast is enabled can another multicast configuration be used.

Configuring the Multicast Route Limit

If the existing route entries exceed the capacity value you configured when using this command, the system will not delete the existing entries, but displays the message, *"Existing route entries exceed the configured capacity value"*.

Perform the following configuration in system view.

Table 4 Configure the Multicast Route Limit

Operation	Command
Configure multicast route limit	**multicast route-limit** *limit*
Restore multicast route limit to the default value	**undo multicast route-limit**

By default, the multicast route-limit is 256.

Clearing MFC Forwarding Entries or Statistic Information

You can clear the multicast forwarding cache (MFC) forward entries or statistical information of FMC forward entries using the **reset multicast forwarding-table** command.

Perform the following configuration in user view.

Table 5 Clear MFC Forwarding Entries or Statistic Information

Operation	Command
Clear MFC forwarding entries or its statistic information	**reset multicast forwarding-table** [**statistics**] { **all** | { *group-address* [**mask** { *group-mask* | *group-mask-length* }] | *source-address* [**mask** { *source-mask* | *source-mask-length* }] | **incoming-interface** *interface-type interface-number* } * }

Clearing Route Entries From the Core Multicast Routing Table

You can clear route entries from the core multicast routing table, as well as MFC forwarding entries using the reset **multicast routing-table** command.

Perform the following configuration in user view.

Table 6 Clear Routing Entries of Multicast Routing Table

Operation	Command
Clear routing entries of multicast routing table	**reset multicast routing-table** { **all** | { group-address [**mask** { group-mask | group-mask-length }] | source-address [**mask** { source-mask | source-mask-length }] | { **incoming-interface** interface-type interface-number } } * }

Displaying and Debugging Common Multicast Configuration

After the previous configurations, execute the **display** command to view the multicast configuration, and to verify the configuration.

Execute the **debugging** command in user view to debug multicast.

Table 7 Display and Debug Common Multicast Configuration

Operation	Command
Display the multicast routing table	**display multicast routing-table** [*group-address* [**mask** { *mask* | *mask-length* }] | *source-address* [**mask** { *mask* | *mask-length* }] | **incoming-interface** { *interface-type interface-number* | **register** }]*
Display the multicast forwarding table	**display multicast forwarding-table** [*group-address* [**mask** { *mask* | *mask-length* }] | *source-address* [**mask** { *mask* | *mask-length* }] | **incoming-interface register** }]*
Display the RPF routing information	**display multicast rpf-info** *source-address*
Enable multicast packet forwarding debugging	debugging multicast forwarding
Disable multicast packet forwarding debugging	undo debugging multicast forwarding
Enable multicast forwarding status debugging	debugging multicast-status forwarding
Disable multicast forwarding status debugging	undo debugging multicast-status forwarding
Enable multicast kernel routing debugging	debugging multicast kernel-routing
Disable multicast kernel routing debugging	undo debugging multicast kernel-routing

Configuring IGMP

IGMP (Internet Group Management Protocol) is a protocol, in the TCP/IP suite, responsible for management of IP multicast members. It is used to establish and maintain multicast membership among IP hosts and their connected neighboring routers. IGMP excludes transmitting and maintenance information among multicast routers, which are completed by multicast routing protocols. All hosts participating in multicast must implement IGMP.

Hosts participating in multicast can join or leave a multicast group at any time, in any place, and without limitation of member numbers. A multicast router does not need and cannot keep the membership of all hosts. It only uses IGMP to learn whether receivers (i.e., group members) of a multicast group are present on the subnet connected to each interface. A host only needs to keep the multicast groups it has joined.

IGMP is not symmetric on hosts and routers. Hosts need to respond to IGMP query messages from the multicast router, i.e., report the group membership to the router. The router needs to send membership query messages periodically to discover whether hosts join the specified group on its subnets according to the received response messages. When the router receives the report that hosts leave the group, the router will send a group-specific query (IGMP Version 2) to discover whether there are no members in the group.

Up to now, IGMP has three versions, IGMP Version 1 (defined by RFC1112), IGMP Version 2 (defined by RFC2236) and IGMP Version 3. IGMP Version 2 is, now, the most widely used version.

IGMP Version 2 boasts the following improvements over IGMP Version 1:

- Election mechanism of multicast routers on the shared network segment

  A shared network segment means that there are multiple multicast routers on a network segment. In this case, all routers running IGMP on the network segment can receive the membership report from hosts. Therefore, only one router is required to send membership query messages. In this case, the router election mechanism is required to specify a router as the querier.

  In IGMP Version 1, selection of the querier is determined by the multicast routing protocol. IGMP Version 2 specifies that the multicast router with the lowest IP address is elected as the querier when there are multiple multicast routers on the same network segment.

- Leaving group mechanism

  In IGMP Version 1, hosts leave the multicast group quietly without informing the multicast router. The multicast router can only depend on the timeout of the response time to confirm when hosts leave the group. In Version 2, when a host leaves a multicast group, it will send a leave group message.

- Specific group query

  In IGMP Version 1, a query of multicast routers is targeted at all the multicast groups on the network segment. This is known as General Query.

  In IGMP Version 2, besides general query, Group-Specific Query is added. The destination IP address of the query packet is the IP address of the multicast group. The group address domain in the packet is also the IP address of the multicast group. This prevents the hosts of members of other multicast groups from sending response messages.

- Max response time

  The Max Response Time is added in IGMP Version 2. It is used to dynamically adjust the allowed maximum time for a host to respond to the membership query message.

Configuring IGMP

Once multicast is enabled, IGMP will automatically run on each interface. Generally, IGMP does not need to be configured. In the following configuration, only the first one is mandatory.

Basic IGMP configuration includes:

- Enabling Multicast
- Enabling IGMP on an Interface

Advanced IGMP configuration includes:

- Configuring the IGMP Version
- Configuring the Interval for Sending the IGMP Group-Specific Query Packet
- Configuring the Interval for Sending IGMP Group-Specific Query Packet
- Configuring the Limit of IGMP Groups on an Interface
- Configuring a Router to be a Member of a Group
- Limiting Access to IP Multicast Groups
- Configuring the IGMP Query Message Interval

- Configuring the IGMP Querier Present Timer
- Configuring the Maximum Query Response Time
- Deleting IGMP Groups Joined on an Interface
- Displaying and Debugging IGMP

Enabling Multicast

After multicast is enabled, IGMP will automatically run on all interfaces.

For details, see "Configuring Common Multicast " on page 172.

Enabling IGMP on an Interface

You must enable multicast before you can execute the **igmp enable** command. After this, you can initiate the IGMP feature configuration.

Perform the following configuration in VLAN interface view.

Table 8 Enable/Disable IGMP on an Interface

Operation	Command
Enable IGMP on an interface	**igmp enable**
Disable IGMP on an interface	**undo igmp enable**

By default, IGMP is not enabled.

Configuring the IGMP Version

Perform the following configuration in VLAN interface view.

Table 9 Select the IGMP Version

Operation	Command
Select the IGMP version that the router uses	**igmp version** { **2** | **1** }
Restore the default setting	**undo igmp version**

The default is IGMP Version 2.

All routers on a subnet must support the same version of IGMP. After detecting the presence of IGMP Version 1 system, a router cannot automatically switch to Version 1.

Configuring the Interval for Sending the IGMP Group-Specific Query Packet

In the shared network, where the same network segment includes multiple hosts and multicast routers, the query router is responsible for maintaining the IGMP group membership on the interface.

When the IGMP v2 host leaves a group, it sends an IGMP Group Leave message. When the IGMP query router receives the IGMP Leave message, it must send the IGMP group query message for the specified number of times (the r*obust-value* parameter in the **igmp robust-count** command, with a default value of 2) in a specified time interval (the *seconds* parameter in the **igmp lastmember-queryinterval** command, with a default value of 1 second).

If other hosts, which are interested in the specified group, receive the IGMP query message from the IGMP query router, they send back the IGMP Membership Report message within the specified maximum response time interval. If the IGMP query router receives the IGMP Membership Report message within the defined period (equal to *robust-value* seconds), it continues to maintain the membership of this group. When the IGMP query router receives no IGMP Membership Report messages from any host within the defined period, it perceives a timeout and stops membership maintenance for the group.

Perform the following configuration in VLAN interface view.

Table 10 Configure The Interval of Sending IGMP Group-Specific Query Packet

Operation	Command
Configure the interval of sending IGMP Group-Specific Query packet	**igmp lastmember-queryinterval seconds**
Restore the interval of sending IGMP Group-Specific Query packet to the default value	**undo igmp lastmember-queryinterval**

By default, the interval is 1 second.

This command is only available on the IGMP query router running IGMP v2. For the host running IGMP v1, this command cannot take effect, because the host may not send the IGMP Leave message when it leaves a group.

Configuring the Interval for Sending IGMP Group-Specific Query Packet

In a shared network where the same network segment including multiple hosts and multicast routers, the query router is responsible for maintaining the IGMP group membership on the interface.

When the IGMP v2 host leaves a group, it sends a IGMP Leave message. When receiving the IGMP Leave message, IGMP query router must send the IGMP group query message for specified times (by the robust-value parameter in the **igmp robust-count** command, with default value as 2) in a specified time interval (by the seconds parameter in the **igmp lastmember-queryinterval** command, with default value as 1 second).

If other hosts, which are interested in the specified group, receive the IGMP query message from the IGMP query router, they will send back the IGMP Membership Report message within the specified maximum response time interval. If the IGMP query router receives the IGMP Membership Report message within the defined period (equal to robust-value seconds), it continues to maintain the membership of this group. When the IGMP query router receives no IGMP Membership Report messages from any hosts within the defined period, it perceives a timeout and stops membership maintenance for the group.

Perform the following configuration in VLAN interface view.

Table 11 Configure the Times of Sending IGMP Group-Specific Query Packet

Operation	Command
Configure the times of sending IGMP Group-Specific Query packet	**igmp robust-count robust-value**

Table 11 Configure the Times of Sending IGMP Group-Specific Query Packet

Operation	Command
Restore the times of sending IGMP Group-Specific Query packet to the default value	**undo igmp robust-count**

By default, the robust-value is 2.

This command is only available on an IGMP query router running IGMP v2. For a host running IGMP v1, this command cannot take effect, because the host may not send the IGMP Leave message when it leaves a group.

Configuring the Limit of IGMP Groups on an Interface

You limit the number of multicast groups, from 0 to 1024, on an interface using the following configuration.

Perform the following configuration in VLAN interface view.

Table 12 Configure the Limit of IGMP Groups on an Interface

Operation	Command
Configure the limit of IGMP groups on an interface	**igmp group-limit** *limit*
Restore the limit of IGMP groups on an interface to the default value	**undo igmp group-limit**

Configuring a Router to be a Member of a Group

Usually, the host operating IGMP will respond to IGMP query packet of the multicast router. In case of a response failure, the multicast router will consider that there is no multicast member on this network segment and will cancel the corresponding path. Configuring one interface of the router as a multicast member can avoid such a problem. When the interface receives an IGMP query packet, the router will respond, ensuring that the network segment is connected and can receive multicast packets.

Perform the following configuration in VLAN interface view.

Table 13 Configure a Router to Be a Member of a Group

Operation	Command
Configure a router to be a member of a group	**igmp host-join** *group-address*
Cancel the configuration that a router is a member of a group	**undo igmp host-join** *group-address*

By default, a router does not join a multicast group.

Limiting Access to IP Multicast Groups

A multicast router learns whether there are members of a multicast group on the network when it receives an IGMP membership message. A filter can be set on an interface to limit the range of allowed multicast groups.

Perform the following configuration in VLAN-interface view.

Table 14 Limit the Access to IP Multicast Groups

Operation	Command
Limit the range of allowed multicast groups on current interface	**igmp group-policy** *acl-number* [**1** | **2**]
Remove the filter set on the interface	**undo igmp group-policy**

By default, no filters are configured. All multicast groups are allowed on the interface.

Configuring the IGMP Query Message Interval

Multicast routers send IGMP query messages to find present multicast groups on other networks. Multicast routers send query messages periodically to refresh their information of members present.

Perform the following configuration in VLAN interface view.

Table 15 Configure the IGMP Query Message Interval

Operation	Command
Configure the IGMP query message interval	**igmp timer query** *seconds*
Restore the IGMP query message interval to the default value	**undo igmp timer query**

When there are multiple multicast routers on a network segment, the querier is responsible for sending IGMP query messages to all hosts on the LAN.

The default interval is 60 seconds.

Configuring the IGMP Querier Present Timer

The IGMP querier present timer defines the period of time before the router takes over as the querier.

Perform the following configuration in VLAN interface view.

Table 16 Configure the IGMP Querier Present Timer

Operation	Command
Change the IGMP querier present timer	**igmp timer other-querier-present** *seconds*
Restore the IGMP querier present timer to the default value	**undo igmp timer other-querier-present**

By default, the value is 120 seconds. If the router has received no query message within twice the interval specified by the **igmp timer query** command, it will regard the previous querier invalid.

Configuring the Maximum Query Response Time

When a router receives a query message, the host will set a timer for each multicast group it belongs to. The value of the timer is randomly selected between 0 and the maximum response time. When any timer becomes 0, the host will send the membership report message of the multicast group.

Setting the maximum response time allows the host to respond to query messages quickly. In this case, the router can master the existing status of the members of the multicast group.

Perform the following configuration in VLAN interface view.

Table 17 Configure the Maximum Query Response Time

Operation	Command
Configure the maximum query response time for IGMP	**igmp max-response-time** *seconds*
Restore the maximum query response time to the default value	**undo igmp max-response-time**

The smaller the maximum query response time value, the faster the router prunes groups. The actual response time is a random value in the range from 1 to 25 seconds. The default value is 10 seconds.

Deleting IGMP Groups Joined on an Interface

You can delete an existing IGMP group from the interface via the following command.

Perform the following configuration in VLAN interface view.

Table 18 Delete IGMP Groups Joined on an Interface

Operation	Command
Delete IGMP groups joined on an interface	**reset igmp group** { **all** | **interface** interface-type interface-number { **all** | group-address [group-mask] } }

Displaying and Debugging IGMP

After the previous configurations, execute the **display** command in all views to display the operation of the IGMP configuration, and to verify the effect of the configuration.

Execute the **debugging** command in user view to debug IGMP.

Table 19 Display and Debug IGMP

Operation	Command
Display the information about members of IGMP multicast groups	**display igmp group** [*group-address* | **interface** *interface-type interface-number*]
Display the IGMP configuration and operational information about the interface	**display igmp interface** [*interface-type interface-number*]
Enable the IGMP information debugging	**debugging igmp { all | event | host | packet | timer }**
Disable the IGMP information debugging	**undo debugging igmp { all | event | host | packet | timer }**

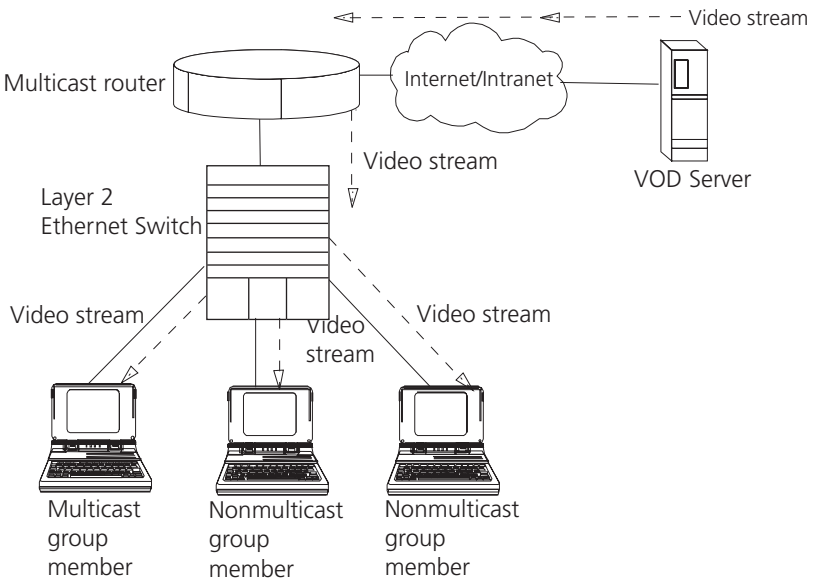
IGMP Snooping

IGMP Snooping (Internet Group Management Protocol Snooping) is a multicast control mechanism running on layer 2. It is used for multicast group management and control.

IGMP Snooping runs on the link layer. When receiving the IGMP messages, the Layer 2 Switch 8800 uses IGMP Snooping to analyze the information. If the switch hears an IGMP host report message from an IGMP host, it adds the host to the corresponding multicast table. If the switch hears IGMP leave a message from an IGMP host, it will remove the host from the corresponding multicast table. The switch continuously listens to the IGMP messages to create and maintain a MAC multicast address table on Layer 2. It can then forward the multicast packets transmitted from the upstream router according to the MAC multicast address table.

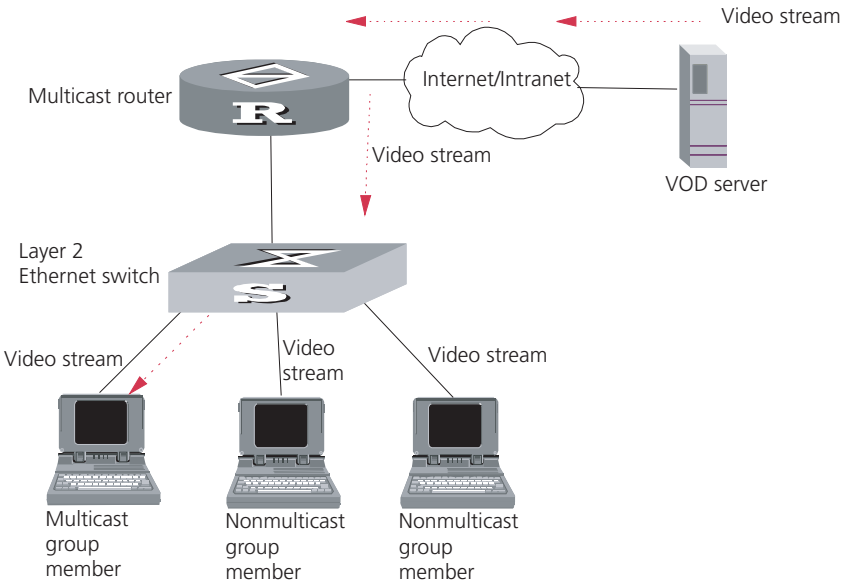
When IGMP Snooping is disabled, the packets are multicast to all ports. See Figure 3.

Figure 3 Multicast Packet Transmission Without IGMP Snooping



Packets are not forwarded to all ports when IGMP operates. See Figure 4.

Figure 4 Multicast Packet Transmission With IGMP Snooping



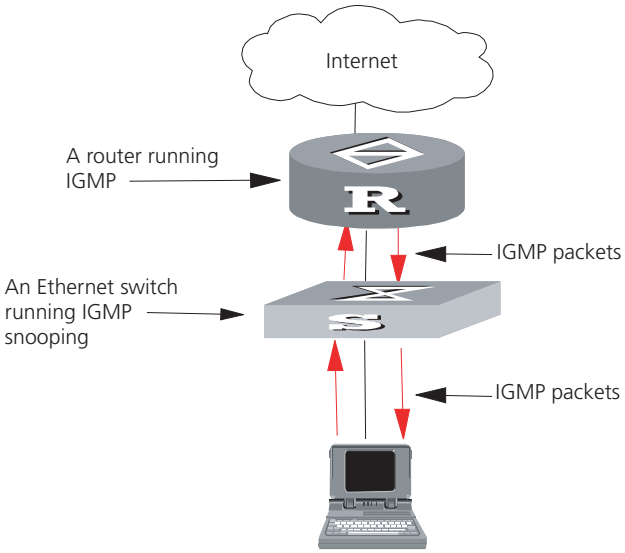
Implement IGMP Snooping

This section introduces related switch concepts of IGMP Snooping:

- Router Port: The port directly connected to the multicast router.
- Multicast member port: The port connected to the multicast member. The multicast member refers to a host that joined a multicast group.
- MAC multicast group: The multicast group is identified with MAC multicast address and maintained by the Switch 8800.
- Router port aging time: Time set on the router port aging timer. If the switch has not received any IGMP general query messages before the timer times out, it is no longer considered a router port.
- Multicast group member port aging time: When a port joins an IP multicast group, the aging timer of the port begins timing. If the switch has not received any IGMP report messages before the timer times out, it transmits IGMP specific query message to the port.
- Maximum response time: When the switch transmits IGMP specific query message to the multicast member port, the Switch 8800 starts a response timer, which times before the response to the query. If the switch has not received any IGMP report message before the timer times out, it will remove the port from the multicast member ports

The Switch 8800 runs IGMP Snooping to listen to the IGMP messages and map the host and its ports to the corresponding multicast group address. To implement IGMP Snooping, Switch 8800 processes different IGMP messages shown in the figure below:

Figure 5 Implementing IGMP Snooping



1 IGMP general query message: Transmitted by the multicast router to query which multicast group contains member. When a router port receives an IGMP general query message, the Switch 8800 will reset the aging timer of the port. When a port other than a router port receives the IGMP general query message, the Switch 8800 will notify the multicast router that a port is ready to join a multicast group and starts the aging timer for the port.

2 IGMP specific query message: Transmitted from the multicast router to the multicast members and used for querying if a specific group contains any member. When received IGMP specific query message, the switch only transmits the specific query message to the IP multicast group which is queried.

3 IGMP report message: Transmitted from the host to the multicast router and used for applying to a multicast group or responding to the IGMP query message. When received, the switch checks if the MAC multicast group is ready to join. If the corresponding MAC multicast group does not exist, the switch notifies the router that a member is ready to join a multicast group, creates a new MAC multicast group, adds the port that received the message to the group, starts the port aging timer, and then adds all the router ports in the native VLAN of the port into the MAC multicast forwarding table. Meanwhile, it creates an IP multicast group and adds the port received to it. If the corresponding MAC multicast group exists but does not contain the port that received the report message, the switch adds the port into the multicast group and starts the port aging timer. Then, the switch checks if the corresponding IP multicast group exists. If it does not exist, the switch creates a new IP multicast group and adds the port that received the report message to it. If it does exist, the switch adds the port. If the corresponding MAC multicast group exists and contains the port, the switch will only reset the aging timer of the port.

4 IGMP leave message: Transmitted from the multicast group member to the multicast router, to notify that a host has left the multicast group. The Switch 8800 transmits the specific query message, concerning the group, to the port that received the message in an effort to check if the host still has other members of this group, and then starts a maximum response timer. If the switch has not received any report message from the multicast group, the port will be removed from the corresponding MAC multicast group. If the MAC multicast group does

not have any member, the switch will notify the multicast router to remove it from the multicast tree.

Configuring IGMP Snooping is described in the following sections:

- Configuring IGMP Snooping
- IGMP Snooping Configuration Example
- Troubleshooting IGMP Snooping

Configuring IGMP Snooping

The main IGMP Snooping configuration includes:

- Enabling/Disabling IGMP Snooping
- Configure Router Port Aging Time
- Configuring Maximum Response Time
- Configure Aging Time of Multicast Group Member
- Displaying and Debugging IGMP Snooping

Of the above configuration tasks, enabling IGMP Snooping is required, while others are optional.

Enabling/Disabling IGMP Snooping

You can use the following commands to enable/disable IGMP Snooping on Layer 2.

Perform the following configuration in system view. To enable IGMP snooping, you must also issue the **igmp-snooping enable** command in VLAN view.

Table 20 Enable/Disable IGMP Snooping

Operation	Command
Enable/disable IGMP Snooping	**igmp-snooping** { **enable** | **disable** }
Restore the default setting	**undo igmp-snooping**

IGMP Snooping and GMRP cannot run at the same time. You can check if GMRP is running by using the **display gmrp status** command, in all views, before enabling IGMP Snooping.

By default, IGMP Snooping is disabled.

Configure Router Port Aging Time

Use this to manually configure the router port aging time. If the switch has not received a general query message from the router prior to it aging, it will remove the port from all the MAC multicast groups.

Perform the following configuration in system view.

Table 21 Configure Router Port Aging Time

Operation	Command
Configure router port aging time	**igmp-snooping router-aging-time** *seconds*
Restore the default aging time	**undo igmp-snooping router-aging-time**

By default, the port aging time is 260 seconds.

Configuring Maximum Response Time

This task sets the maximum response time. If the Switch 8800 receives no report message from a port in the maximum response time, it will remove the port from the multicast group.

Perform the following configuration in system view.

Table 22 Configuring the Maximum Response Time

Operation	Command
Configure the maximum response time	**igmp-snooping max-response-time** *seconds*
Restore the default setting	**undo IGMP-snooping max-response-time**

By default, the maximum response time is 10 seconds.

Configure Aging Time of Multicast Group Member

This task sets the aging time of the multicast group member port. If the switch receives no multicast group report message during the member port aging time, it will transmit the specific query message to that port and start a maximum response timer.

Perform the following configuration in system view.

Table 23 Configure Aging Time of the Multicast Member

Operation	Command
Configure aging time of the multicast member	**igmp-snooping host-aging-time** *seconds*
Restore the default setting_	**undo igmp-snooping host-aging-time**

By default, the aging time of the multicast member is 260 seconds.

Displaying and Debugging IGMP Snooping

Execute the **display** command in all views to display the operation of the IGMP Snooping configuration, and to verify the effect of the configuration. Execute the **reset** command in user view to reset the IGMP Snooping statistic information. Execute the **debugging** command in user view to debug IGMP Snooping configuration.

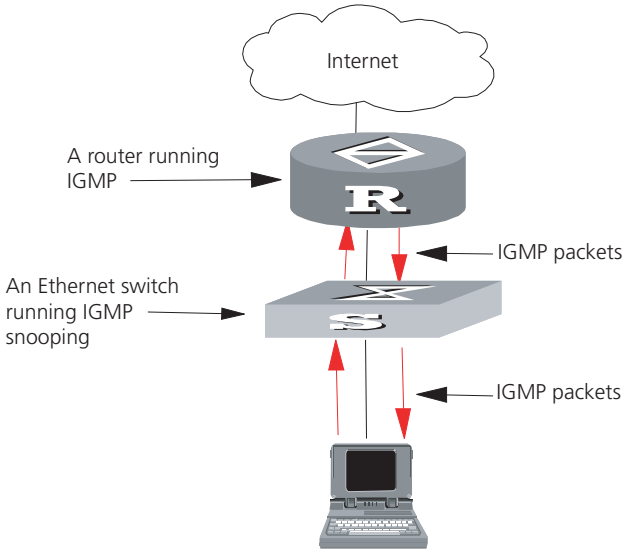
Table 24 Display and Debug IGMP Snooping

Operation	Command
Display the information about current IGMP Snooping configuration_	**display igmp-snooping configuration**
Display IGMP Snooping statistics of received and sent messages_	**display igmp-snooping statistics**
Display IP/MAC multicast group information in the VLAN_	**display igmp-snooping group** [**vlan** *vlanid*]
Enable/disable IGMP Snooping debugging (abnormal, group, packet, timer).	**debug igmp-snooping** { **all | abnormal | group | packet | timers** }
Reset the IGMP Snooping statistic information	**reset igmp-snooping statistics**
Disable IGMP Snooping debugging (abnormal, group, packet, timer).	**undo debug igmp-snooping { all | abnormal | group | packet | timers }**

IGMP Snooping Configuration Example

To implement IGMP Snooping on the switch, first enable it. The switch is connected with the router through the router port, and with user PC through the non-router ports.

Figure 6 IGMP Snooping Configuration Network



1 Display the status of GMRP.

```
<SW8800>display gmrp status
```

2 Display the current status of IGMP Snooping when GMRP is disabled.

```
<SW8800>display igmp-snooping configuration
```

3 Enable IGMP Snooping if it is disabled.

```
[SW8800]igmp-snooping enable
```

Troubleshooting IGMP Snooping

If the multicast function cannot be implemented on the switch, check for the following conditions and use the accompanying troubleshooting procedure:

1 IGMP Snooping is disabled.

- Input the **display current-configuration** command to display the status of IGMP Snooping.
- If the switch disabled IGMP Snooping, you can input **igmp-snooping enable** in the system view to enable IGMP Snooping.

2 Multicast forwarding table set up by IGMP Snooping is wrong.

- Input the display **igmp-snooping group** command to see if the multicast group is the expected one.
- Verify that the source IP address is correct for each multicast stream.

3 Multicast forwarding table set up on the bottom layer is wrong.

- Enable IGMP Snooping group in user view and then input the **display igmp-snooping group** command to check if MAC multicast forwarding table in the bottom layer and that created by IGMP Snooping is consistent. You may also input the **display mac vlan** command in all views to check if MAC multicast forwarding table under vlanid in the bottom layer and that created by IGMP Snooping is consistent.

- If they are not consistent, contact the maintenance personnel for help.

Configuring PIM-DM

PIM-DM (Protocol Independent Multicast, Dense Mode) belongs to dense mode multicast routing protocols. PIM-DM is suitable for small networks. Members of multicast groups are relatively dense in such network environments.

The working procedures of PIM-DM include neighbor discovery, flood and prune, and graft.

- Neighbor discovery

  The PIM-DM router needs to use Hello messages to perform neighbor discovery when it is started. All network nodes running PIM-DM keep in touch with one another with Hello messages, which are sent periodically.

- Flood and Prune

  PIM-DM assumes that all hosts on the network are ready to receive multicast data. When a multicast source "S" begins to send data to a multicast group "G", after the router receives the multicast packets, the router will perform RPF check according to the unicast routing table first. If the RPF check is passed, the router will create an (S, G) entry and then flood the data to all downstream PIM-DM nodes. If the RPF check is not passed, that is when multicast packets enter from an error interface, the packets will be discarded. After this process, an (S, G) entry will be created in the PIM-DM multicast domain.

  If the downstream node has no multicast group members, it will send a Prune message to the upstream nodes to inform the upstream node not to forward data to the downstream node. Receiving the prune message, the upstream node will remove the corresponding interface from the outgoing interface list corresponding to the multicast forwarding entry (S, G). In this way, a SPT (Shortest Path Tree) rooted at Source S is built. Leaf routers initiate the pruning process.

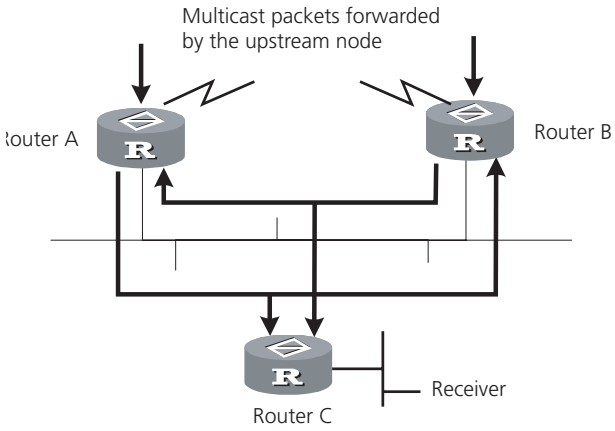
  This is called the "flood & prune" process. Nodes that are pruned provide timeout mechanism. Each router re-starts the "flood & prune" process upon pruning timeout. The consistent "flood & prune" process of PIM-DM is performed periodically.

  During this process, PIM-DM uses the RPF check and the existing unicast routing table to build a multicast forwarding tree rooted at the data source. When a packet arrives, the router judges the validity of the path. If the interface is indicated by the unicast routing to the multicast source, the packet is regarded to be from the correct path, otherwise, the packet will be discarded as a redundancy packet without the multicast forwarding. The unicast routing information as path judgment can come from any unicast routing protocol independent of any specified unicast routing protocol such as the routing information learned by RIP and OSPF.

- Assert mechanism

  As shown in the following figure, both routers A and B on the LAN have their own receiving paths to multicast source S. In this case, when they receive a multicast packet sent from multicast source S, they will both forward the packet to the LAN. Multicast Router C at the downstream node will receive two copies of the same multicast packet.

Figure 7 Assert Mechanism Diagram



When they detect such a case, routers need to select a unique sender by using the assert mechanism. Routers send Assert packets to select the best path. If two or more have the same priority and metric, the path with a higher IP address will be the upstream neighbor of the (S, G) entry. This is responsible for forwarding the (S, G) multicast packet.

- Graft

  When the pruned downstream node needs to be restored to the forwarding state, the node will send a graft packet to inform the upstream node.

Configuring PIM-DM is described in the following sections:

- Configuring PIM-DM
- PIM-DM Configuration Example

Configuring PIM-DM

Basic PIM-DM configuration includes:

- Enabling Multicast
- Enabling PIM-DM
- Entering PIM View

Advanced PIM-DM configuration includes:

- Configuring the Interface Hello Message Interval
- Configuring the Filtering of Multicast Source/Group
- Configuring the Filtering of PIM Neighbors
- Configuring the Maximum Number of PIM Neighbor on an Interface
- Clearing PIM Neighbors
- Displaying and Debugging PIM-DM

When the router is run in the PIM-DM domain, it is best to enable PIM-DM on all interfaces of the non-border router.

Enabling Multicast

See "Configuring Common Multicast " on page 172.

Enabling PIM-DM

PIM-DM needs to be enabled in the configuration of all interfaces.

After PIM-DM is enabled on an interface, it will send PIM Hello messages periodically, and process protocol packets sent by PIM neighbors.

Perform the following configuration in VLAN interface view.

Table 25 Enable PIM-DM

Operation	Command
Enable PIM-DM on an interface	**pim dm**
Disable PIM-DM on an interface	**undo pim dm**

3Com recommends that you configure PIM-DM on all interfaces. This configuration is effective only after the multicast routing is enabled in system view.

Once you enable PIM-DM on an interface, PIM-SM cannot be enabled on the same interface and vice versa.

Entering PIM View

Global parameters of PIM should be configured in PIM view.

Perform the following configuration in system view.

Table 26 Entering PIM View

Operation	Command
Enter PIM view	**pim**
Return to system view	**undo pim**

Use the **undo pim** command to clear the configuration in PIM view, and to return to system view.

Configuring the Interface Hello Message Interval

After PIM is enabled on an interface, it will send Hello messages periodically. The interval at which Hello messages are sent can be modified according to the bandwidth and type of the network connected to the interface.

Perform the following configuration in VLAN interface view.

Table 27 Configure Hello Message Interval on an Interface

Operation	Command
Configure the hello message interval on an interface	**pim timer hello** *seconds*
Restore the interval to the default value	**undo pim timer hello**

The default interval is 30 seconds. You can configure the value according to different network environments. Generally, this parameter does not need to be modified.

This configuration can be performed only after PIM (PIM-DM or PIM-SM) is enabled in VLAN interface view.

Configuring the Filtering of Multicast Source/Group

You can set to filter the source (and group) address of multicast data packets via this command. When this feature is configured, the router filters not only multicast data, but the multicast data encapsulated in the registration packets.

Perform the following configuration in the PIM view.

Table 28 Configuring the Filtering of Multicast Source/Group

Operation	Command
Configure the filtering of multicast source/group	**source-policy** *acl-number*
Remove the configuration of filtering	**undo source-policy**

If resource address filtering is configured, as well as basic ACLs, then the router filters the resource addresses of all multicast data packets received. Those not matched will be discarded.

If resource address filtering is configured, as well as advanced ACLs, then the router filters the resource and group addresses of all multicast data packets received. Those not matched will be discarded.

Configuring the Filtering of PIM Neighbors

You can set to filter the PIM neighbors on the current interface via the following configuration.

Perform the following configuration in the PIM view.

Table 29 Configuring the Filtering of PIM Neighbors

Operation	Command
Configure filtering of PIM neighbor	**pim neighbor-policy** *acl-number*
Remove the configuration of filtering	**undo pim neighbor-policy**

By default, no filtering rules are set.

Only the routers that match the filtering rule in the ACL can serve as a PIM neighbor of the current interface.

Configuring the Maximum Number of PIM Neighbor on an Interface

You can limit the PIM neighbors on an interface. No neighbor can be added any more when the limit is reached.

Perform the following configuration in the PIM view.

Table 30 Configure the Maximum Number of PIM Neighbor on an Interface

Operation	Command
Configure the maximum number of PIM neighbor on an interface	**pim neighbor-limit** *limit*
Restore the limit of PIN neighbor to the default value	**pim neighbor-limit**

By default, the PIM neighbors on the interface are limited to 128.

If the existing PIM neighbors exceed the configured value during configuration, they are not deleted.

Clearing PIM Neighbors

Perform the following configuration in user view.

Table 31 Resetting PIM Neighbors

Operation	Command
Clear PIM neighbors	**reset pim neighbor** { *all* | { *neighbor-address* | *interface interface-type interface-number* } * }

Displaying and Debugging PIM-DM

Execute the **display** command in all views to display the operation of the PIM-DM configuration, and to verify the effect of the configuration.

Execute the **debugging** command in user view for the debugging of PIM-DM.

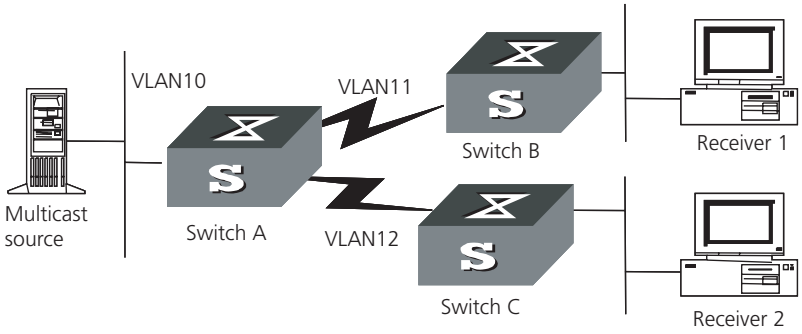
Table 32 Displaying and Debugging PIM-DM

Operation	Command
Display the PIM multicast routing table	**display pim routing-table** [{ { *__g__ [*group-address* [**mask** { *mask-length* | *mask* }]] | **__rp__ [*rp-address* [**mask** { *mask-length* | *mask* }]] } | { *group-address* [**mask** { *mask-length* | *mask* }] | *source-address* [**mask** { *mask-length* | *mask* }] } * } | **incoming-interface** { *interface-type interface-num* | *interface-name* | **null** } | { **dense-mode | sparse-mode }**] *
Display the PIM interface information	**display pim interface** [*interface-type interface-number*]
Display the information about PIM neighboring routers	**display pim neighbor** [**interface** *interface-type interface-number*]
Enable the PIM debugging	**debugging pim common** { **all** | **event** | **packet** | **timer** }
Disable the PIM debugging	**undo debugging pim common** { **all** | **event** | **packet** | **timer** }
Enable the PIM-DM debugging	**debugging pim dm** { **alert** | **all** | **mbr** | **mrt** | **timer** | **warning** | { **recv** | **send** } { **all** | **assert** | **graft** | **graft-ack** | **join** | **prune** } }
Disable the PIM-DM debugging	**undo debugging pim dm** { **alert** | **all** | **mbr** | **mrt** | **timer** | **warning** | { **recv** | **send** } { **all** | **assert** | **graft** | **graft-ack** | **join** | **prune** } }

PIM-DM Configuration Example

LS_A has a port carrying Vlan 10 to connect Multicast Source, a port carrying Vlan11 to connect LS_B and a port carrying Vlan12 to connect LS_C. Configure to implement multicast between Multicast Source and Receiver 1 and Receiver 2.

Figure 8 PIM-DM Configuration Networking



Configuration procedure

This section only provides the configuration for Switch A because the configuration procedures for Switch B and Switch C are similar.

1 Enable the multicast routing protocol.

```
[SW8800]multicast routing-enable
```

2 Enable PIM-DM.

```
[SW8800]vlan 10
[SW8800-vlan10] port GigabitEthernet1/1/2 to GigabitEthernet1/1/3
[SW8800-vlan10] quit
[SW8800]vlan 11
[SW8800-vlan11] port GigabitEthernet1/1/4 to GigabitEthernet1/1/5
[SW8800-vlan11] quit
[SW8800]vlan 12
[SW8800-vlan12] port GigabitEthernet1/1/6 to GigabitEthernet1/1/7
[SW8800-vlan12] quit
[SW8800]interface vlan-interface 10
[SW8800-vlan-interface10] ip address 1.1.1.1 255.255.0.0
[SW8800-vlan-interface10] igmp enable
[SW8800-vlan-interface10] pim dm
[SW8800-vlan-interface10] quit
[SW8800]interface vlan-interface 11
[SW8800-vlan-interface11] ip address 2.2.2.2 255.255.0.0
[SW8800-vlan-interface11] igmp enable
[SW8800-vlan-interface11] pim dm
[SW8800-vlan-interface11] quit
[SW8800]interface vlan-interface 12
[SW8800-vlan-interface12] ip address 3.3.3.3 255.255.0.0
[SW8800-vlan-interface12] igmp enable
[SW8800-vlan-interface12] pim dm
```

Configuring PIM-SM

PIM-SM (Protocol Independent Multicast, Sparse Mode) belongs to sparse mode multicast routing protocols. PIM-SM is mainly applicable to large-scale networks with broad scope and few group members.

Different from the flood & prune principle of the dense mode, PIM-SM assumes that all hosts do not need to receive multicast packets, unless clear request is put forward.

PIM-SM uses the RP (Rendezvous Point) and the BSR (Bootstrap Router) to advertise multicast information to all PIM-SM routers and uses the join/prune

information of the router to build the RP-rooted shared tree (RPT). This helps to reduce the bandwidth occupied by data packets and control packets, and reduces the process overhead of the router. Multicast data flows along the shared tree to the network segments. When data traffic is sufficient, the multicast data flow switches over to the SPT (Shortest Path Tree) rooted on the source. This reduces network delay. To perform the RPF check, PIM-SM does not depend on the specified unicast routing protocol but uses the present unicast routing table.

If your switch is using PIM-SM, you must configure candidate RPs and BSRs. The BSR is responsible for collecting the information from the candidate RP and advertising the information.

Configuring PIM-SM is described in the following sections:

- PIM-SM Operating Principles
- Preparing to Configure PIM-SM
- Configuring PIM-SM

PIM-SM Operating Principles

The PIM-SM working process is as follows: neighbor discovery, building the RP-rooted shared tree (RPT), multicast source registration and SPT switchover etc. The neighbor discovery mechanism is the same as that of PIM-DM.

Build the RP shared tree (RPT)

When hosts join a multicast group G, the leaf routers send IGMP messages to learn the receivers of the multicast group G. The leaf routers calculate the corresponding rendezvous point (RP) for multicast group G, and then send join messages to the node of a higher level toward the rendezvous point (RP). Each router along the path, between the leaf routers and the RP, will generate (*, G) entries in the forwarding table, indicating that all packets sent to multicast group G are applicable. When the RP receives packets sent to multicast group G, the packets will be sent to leaf routers along the path built and then reach the hosts. In this way, an RP-rooted tree (RPT) is built as shown in the following figure.

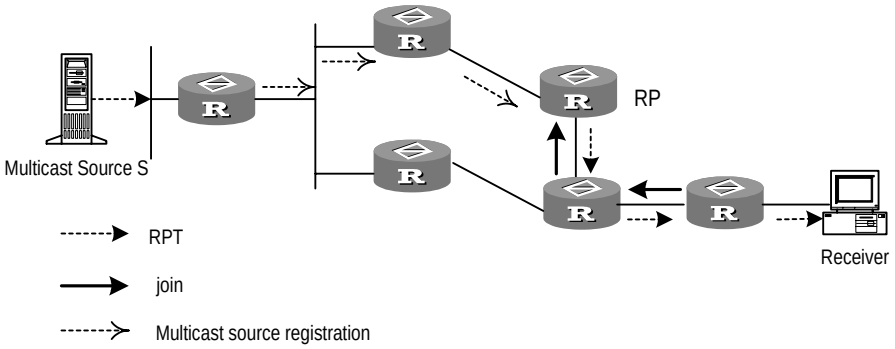
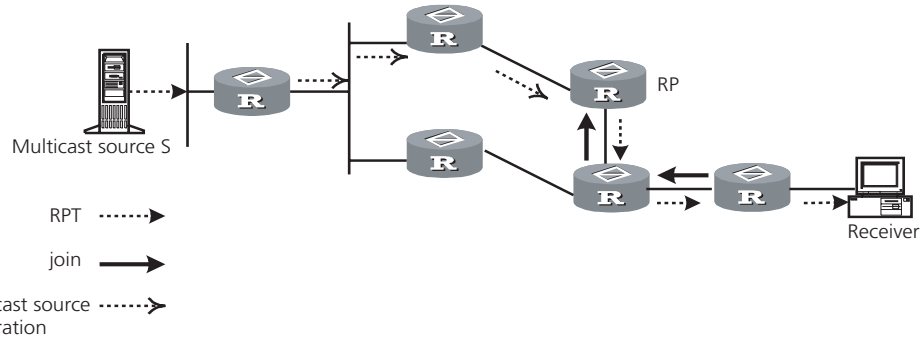


Figure 9 RPT Schematic Diagram



Multicast Source Registration

When multicast source S sends a multicast packet to group G, the PIM-SM multicast router is responsible for encapsulating the packet into a registration packet upon receipt. It then sends the packet to the corresponding RP in unicast. If there are multiple PIM-SM multicast routers on a network segment, the Designated Router (DR) will be responsible for sending the multicast packet.

Preparing to Configure PIM-SM

Tasks for preparing to Configure PIM-SM are described in the following sections:

- Configure Candidate RPs
- Configure BSRs
- Configure Static RP

Configure Candidate RPs

In a PIM-SM network, multiple RPs (candidate-RPs) can be configured. Each Candidate-RP (C-RP) is responsible for forwarding multicast packets with the destination addresses in a certain range. Configuring multiple C-RPs is to implement load balancing of the RP. These C-RPs are equal. All multicast routers

calculate the RPs corresponding to multicast groups according to the same algorithm, after receiving the C-RP messages that the BSR advertises.

One RP can serve multiple multicast groups or all multicast groups. Each multicast group can only be uniquely correspondent to one RP at a time rather than multiple RPs.

Configure BSRs

The BSR is the management core in a PIM-SM network. Candidate-RPs send announcement to the BSR, which is responsible for collecting and advertising the information about all candidate-RPs.

It should be noted that there can be only one BSR in a network but you can configure multiple candidate-BSRs. In this case, once a BSR fails, you can switch over to another BSR. A BSR is elected among the C-BSRs automatically. The C-BSR with the highest priority is elected as the BSR. If the priority is the same, the C-BSR with the largest IP address is elected as the BSR.

Configure Static RP

The router that serves as the RP is the core router of multicast routes. If the dynamic RP elected by BSR mechanism is invalid for some reason, the static RP can be configured to specify RP. As the backup of dynamic RP, static RP improves network robustness and enhances the operation and management capability of multicast network.

Configuring PIM-SM

Basic PIM-SM configuration includes:

- Enabling Multicast
- Enabling IGMP on an Interface
- Enabling PIM-SM
- Setting the PIM-SM Domain Border
- Entering PIM View
- Configuring Candidate-BSRs
- Configuring Candidate-RPs
- Configuring Static RP

Advanced PIM-SM configuration includes:

- Configuring the Interface Hello Message Interval
- Configuring the Filtering of Multicast Source/Group
- Configuring the Filtering of PIM Neighbor
- Configuring the Maximum Number of PIM Neighbor on an Interface
- Configuring RP to Filter the Register Messages Sent by DR
- Limiting the Range of Legal BSR
- Limiting the Range of Legal C-RP
- Clearing Multicast Route Entries from PIM Routing Table
- Clearing PIM Neighbors

- Displaying and Debugging PIM-SM

At least one router in an entire PIM-SM domain should be configured with Candidate-RPs and Candidate-BSRs.

Enabling Multicast

Refer to "Configuring Common Multicast " on page 172.

Enabling IGMP on an Interface

Refer to "Configuring IGMP" on page 174.

Enabling PIM-SM

This configuration can be effective only after multicast is enabled.

Perform the following configuration in VLAN interface view.

Table 33 Enabling PIM-SM

Operation	Command
Enable PIM-SM on an interface	**pim sm**
Disable PIM-SM on an interface	**undo pim sm**

Repeat this configuration to enable PIM-SM on other interfaces. Only one multicast routing protocol can be enabled on an interface at a time.

Once enabled, PIM-DM cannot be enabled on the same interface.

Setting the PIM-SM Domain Border

After the PIM-SM domain border is configured, bootstrap messages cannot cross the border in any direction. In this way, the PIM-SM domain can be split.

Perform the following configuration in VLAN interface view.

Table 34 Setting the PIM-SM Domain Border

Operation	Command
Set the PIM-SM domain border	**pim bsr-boundary**
Remove the PIM-SM domain border configured	**undo pim bsr-boundary**

By default, no domain border is set. After this configuration is performed, a bootstrap message cannot cross the border, but other PIM packets can. This configuration can effectively divide a network into domains using different BSRs.

This command cannot create a multicast packet forwarding border but only a PIM bootstrap message border.

Entering PIM View

Global parameters of PIM should be configured in PIM view.

Perform the following configuration in system view.

Table 35 Entering PIM View

Operation	Command
Enter PIM view	**pim**
Back to system view	**undo pim**

Using **undo pim** command, you can clear the configuration in PIM view and back to system view.

Configuring Candidate-BSRs

In a PIM domain, one or more candidate BSRs should be configured. A BSR (Bootstrap Router) is elected among candidate BSRs. The BSR takes charge of collecting and advertising RP information.

The automatic election among candidate BSRs is described as follows. One interface which has started PIM-SM, must be specified when configuring the router as the candidate BSR. At first, each candidate BSR considers itself as the BSR of the PIM-SM domain, and sends a Bootstrap message by taking the IP address of the interface as the BSR address. When receiving Bootstrap messages from other routers, the candidate BSR will compare the BSR address of the newly received Bootstrap message with that of itself. Comparison standards include priority and IP address. The bigger IP address is considered better when the priority is the same. If the new BSR address is better, the candidate BSR will replace its BSR address. Otherwise, the candidate BSR will keep its BSR address and continue to regard itself as the BSR.

Perform the following configuration in PIM view.

Table 36 Configuring Candidate-BSRs

Operation	Command
Configure a candidate-BSR	**c-bsr** *interface-type interface-number hash-mask-len* [*priority*]
Remove the candidate-BSR configured	**undo c-bsr**

Candidate-BSRs should be configured on the routers in the network backbone. By default, no BSR is set. The default priority is 0.

Only one router can be configured with one candidate-BSR. When a candidate-BSR is configured on another interface, it will replace the previous configuration.

Configuring Candidate-RPs

In PIM-SM, the shared tree built by the multicast routing data is rooted at the RP. There is mapping from a multicast group to an RP. A multicast group can be mapped to an RP. Different groups can be mapped to one RP.

Perform the following configuration in PIM view.

Table 37 Configuring Candidate-RPs

Operation	Command
Configure a candidate-RP	**c-rp** *interface-type interface-number* [**group-policy** *acl-number*]
Remove the candidate-RP configured	**undo c-rp** *interface-type interface-number*

If the range of the served multicast group is not specified, the RP will serve all multicast groups. Otherwise, the range of the served multicast group is the multicast group in the specified range. It is suggested to configure Candidate RP on the backbone router.

Configuring Static RP

Static RP serves as the backup of dynamic RP to make the network more robust.

Perform the following configuration in PIM view.

Table 38 Configuring Static RP

Operation	Command
Configure static RP	**static-rp** *rp-address* [*acl-number*]
Configure static RP	**undo static-rp**

Basic ACLs can control the range of the multicast group served by static RP.

If static RP is in use, all routers in the PIM domain must adopt the same configuration. If the configured static RP address is the interface address of the local router whose state is UP, the router will function as the static RP. It is unnecessary to enable PIM on the interface that functions as static RP.

When the RP elected from BSR mechanism is valid, static RP does not work.

Configuring the Interface Hello Message Interval

Generally, PIM-SM advertises Hello messages periodically on the interface enabled with it to detect PIM neighbors and discover which router is the Designated Router (DR).

Perform the following configuration in VLAN interface view.

Table 39 Configuring the Interface Hello Message Interval

Operation	Command
Configure the interface hello message interval	**pim timer hello** *seconds*
Restore the interval to the default value	**undo pim timer hello**

By default, the hello message interval is 30 seconds. Users can configure the value according to different network environments.

This configuration can be performed only after the PIM (PIM-DM or PIM-SM) is enabled in VLAN interface view.

Configuring the Filtering of Multicast Source/Group

See "Configuring PIM-DM" on page 187.

Configuring the Filtering of PIM Neighbor

See "Configuring PIM-DM" on page 187.

Configuring the Maximum Number of PIM Neighbor on an Interface

See "Configuring PIM-DM" on page 187.

Configuring RP to Filter the Register Messages Sent by DR

In the PIM-SM network, the register message filtering mechanism can control which sources to send messages to, which groups on the RP, i.e., RP can filter the register messages sent by DR to accept specified messages only.

Perform the following configuration in PIM view.

Table 40 Configuring RP to Filter the Register Messages Sent by DR

Operation	Command
Configure RP to filter the register messages sent by DR	**register-policy** *acl-number*
Cancel the configured filter of messages	**undo register-policy**

If an entry of a source group is denied by the ACL, or the ACL does not define operation to it, or there is no ACL defined, the RP will send RegisterStop messages to the DR to prevent the register process of the multicast data stream.

*Only the register messages matching the ACL **permit** clause can be accepted by the RP. Specifying an undefined ACL will make the RP deny all register messages.*

Limiting the Range of Legal BSR

In a PIM SM network that uses a bootstrap router (BSR), every router can set itself as a candidate BSR (C-BSR) and take the authority to advertise RP information in the network when it wins in the contention. To prevent malicious BSR spoofing in the network, the following two measures need to be taken:

- Prevent the router from being spoofed by hosts using a stolen identity from legal BSR messages to modify RP mapping. BSR messages are of multicast type and their TTL is 1, so these types of attacks often hit edge routers. Fortunately, BSRs are inside the network, while assaulting hosts are outside, therefore neighbor and RPF checks can be used to stop these types of attacks.
- If a router in the network is manipulated by an attacker, or an illegal router is accessed into the network, the attacker may set itself as C-BSR and try to win the contention and gain authority to advertise RP information among the network. Since the router configured as C-BSR shall propagate BSR messages, which are multicast messages sent hop by hop with TTL as 1, among the network, then the network cannot be affected as long as the peer routers do not receive these BSR messages. One way is to configure bsr-policy on each router to limit legal BSR range, for example, only 1.1.1.1/32 and 1.1.1.2/32 can be BSR, thus the routers cannot receive or forward BSR messages other than these two. Even legal BSRs cannot contest with them.

Perform the following configuration in PIM view.

Table 41 Limiting the Range of Legal BSR

Operation	Command
Limit the legal BSR range	**bsr-policy** *acl-number*
Restore to the default setting	**undo bsr-policy**

For detailed information of the **bsr-policy** command, see the *Switch 8800 Command Reference Guide*.

Limiting the Range of Legal C-RP

In the PIM SM network, using BSR mechanism, every router can set itself as the C-RP (candidate rendezvous point) servicing particular groups. If elected, a C-RP becomes the RP servicing the current group.

In the BSR mechanism, a C-RP router unicasts C-RP messages to the BSR, which then propagates the C-RP messages among the network by BSR message. To prevent C-RP spoofing, you need to configure crp-policy on the BSR to limit legal C-RP range and their service group range. Since each C-BSR has the chance to become BSR, you must configure the same filtering policy on each C-BSR router.

Perform the following configuration in PIM view.

Table 42 Limiting the Range of Legal C-RP

Operation	Command
Limit the legal C-RP range	**crp-policy** *acl-number*
Restore to the default setting	**undo crp-policy**

For detailed information of the **crp-policy** command, see the *Switch 8800 Command Reference Guide*.

Clearing Multicast Route Entries from PIM Routing Table

Perform the following configuration in user view.

Table 43 Clearing Multicast Route Entries from PIM Routing Table

Operation	Command
Clear multicast route entries from PIM routing table	**reset pim routing-table** { **all** | { *group-address* [**mask** *group-mask* | **mask-length** *group-mask-length*] | *source-address* [**mask** *source-mask* | **mask-length** *source-mask-length*] | { **incoming-interface** { *interface-type interface-number* | **null** } } } * }

If in this command, the *group-address* is 224.0.0.0/24 and *source-address* is the RP address (where group address can have a mask, but the resulting IP address must be 224.0.0.0, and source address has no mask), then it means only the (*, *, RP) item will be cleared.

If in this command, the *group-address* is any group address, and *source-address* is 0 (where group address can have a mask, and source address has no mask), then only the (*, G) item will be cleared.

This command clears multicast route entries from PIM routing table, as well as the corresponding route entries and forward entries in the multicast core routing table and MFC.

Clearing PIM Neighbors

Perform the following configuration in user view.

Table 44 Clearing PIM Neighbors

Operation	Command
Clear PIM neighbors	**reset pim neighbor** { **all** | { *neighbor-address* | **interface** *interface-type interface-number* } * }

Displaying and Debugging PIM-SM

Execute the **display** command in all views to display the PIM-SM configuration, and to verify the configuration.

Execute the **debugging** command in user view to debug PIM-SM.

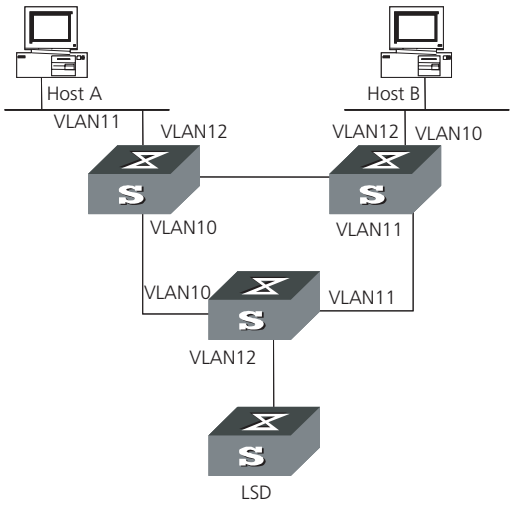
Table 45 Display and Debug PIM-SM

Operation	Command
Display the BSR information	**display pim bsr-info**
Display the RP information	**display pim rp-info** [*group-address*]
Enable the PIM-SM debugging	**debugging pim sm** { **all** | **mbr** | **register-proxy** | **mrt** | **timer** | **warning** | { **recv** | **send** } { **assert** | **graft** | **graft-ack** | **join** | **prune** } }
Disable the PIM-SM debugging	**undo debugging pim sm** { **all** | **mbr** | **register-proxy** | **mrt** | **timer** | **warning** | { **recv** | **send** } { **assert** | **graft** | **graft-ack** | **join** | **prune** } }

Example: Configuring PIM-SIM

Host A is the receiver of the multicast group at 225.0.0.1. Host B begins transmitting data destined to 225.0.0.1. Switch A receives the multicast data from Host B by Switch B.

Figure 10 PIM-SM Configuration Networking



Configure Switch A

1 Enable PIM-SM.

```
[SW8800]multicast routing-enable
[SW8800]vlan 10
[SW8800-vlan10] port GigabitEthernet1/1/2 to GigabitEthernet1/1/3
[SW8800-vlan10] quit
[SW8800]interface vlan-interface 10
[SW8800-vlan-interface10] pim sm
[SW8800-vlan-interface10] quit
[SW8800]vlan 11
[SW8800-vlan11] port GigabitEthernet1/1/4 to GigabitEthernet1/1/5
[SW8800-vlan11] quit
[SW8800]pim
[SW8800-pim] interface vlan-interface 11
[SW8800-vlan-interface11] pim sm
[SW8800-vlan-interface11] quit
[SW8800]vlan 12
[SW8800-vlan12] port GigabitEthernet1/1/6 to GigabitEthernet1/1/7
[SW8800-vlan12] quit
[SW8800]pim
[SW8800-pim] interface vlan-interface 12
[SW8800-vlan-interface12] pim sm
[SW8800-vlan-interface12] quit
```

Configure Switch B

1 Enable PIM-SM.

```
[SW8800]multicast routing-enable
[SW8800]vlan 10
[SW8800-vlan10] port GigabitEthernet1/1/2 to GigabitEthernet1/1/3
[SW8800-vlan10] quit
[SW8800]pim
[SW8800-pim] interface vlan-interface 10
[SW8800-vlan-interface10] pim sm
[SW8800-vlan-interface10] quit
[SW8800]vlan 11
[SW8800-vlan11] port GigabitEthernet1/1/4 to GigabitEthernet1/1/5
[SW8800-vlan11] quit
[SW8800]pim
[SW8800-pim] interface vlan-interface 11
[SW8800-vlan-interface11] pim sm
[SW8800-vlan-interface11] quit
[SW8800]vlan 12
[SW8800-vlan12] port GigabitEthernet1/1/6 to GigabitEthernet1/1/7
[SW8800-vlan12] quit
[SW8800]pim
[SW8800-pim] interface vlan-interface 12
[SW8800-vlan-interface12] pim sm
[SW8800-vlan-interface12] quit
```

2 Configure the C-BSR.

```
[SW8800]pim
[SW8800-pim] c-bsr vlan-interface 10 30 2
```

3 Configure the C-RP.

```
[SW8800]acl number 2005
[SW8800-acl-basic-2005] rule permit source 225.0.0.0 0.255.255.255
```

```
[SW8800]pim
[SW8800-pim] c-rp vlan-interface 10 group-policy 2005
```

4 Configure PIM domain border.

```
[SW8800]interface vlan-interface 12
[SW8800-vlan-interface12] pim bsr-boundary
```

After VLAN-interface 12 is configured as BSR, the LS_D will be excluded from the local PIM domain and cannot receive the BSR information transmitted from LS_B anymore.

Configure Switch C:

1 Enable PIM-SM.

```
[SW8800]multicast routing-enable
[SW8800]vlan 10
[SW8800-vlan10] port GigabitEthernet1/1/2 to GigabitEthernet1/1/3
[SW8800-vlan10] quit
[SW8800]pim
[SW8800-pim] interface vlan-interface 10
[SW8800-vlan-interface10] pim sm
[SW8800-vlan-interface10] quit
[SW8800]vlan 11
[SW8800-vlan11] port GigabitEthernet1/1/4 to GigabitEthernet1/1/5
[SW8800-vlan11] quit
[SW8800]pim
[SW8800-pim] interface vlan-interface 11
[SW8800-vlan-interface11] pim sm
[SW8800-vlan-interface11] quit
[SW8800]vlan 12
[SW8800-vlan12] port GigabitEthernet1/1/6 to GigabitEthernet1/1/7
[SW8800-vlan12] quit
[SW8800]pim
[SW8800-pim] interface vlan-interface 12
[SW8800-vlan-interface12] pim sm
[SW8800-vlan-interface12] quit
```

GMRP

GMRP (GARP Multicast Registration Protocol), based on GARP, is used for maintaining dynamic multicast registration information. All the switches supporting GMRP can receive multicast registration information from other switches, and dynamically update local multicast registration information. Local multicast registration information can be transmitted to other switches. This information switching mechanism keeps consistency of multicast information maintained by every GMRP-supporting device in the same switching network.

A host transmits GMRP Join message. After receiving the message, the switch adds the port to the multicast group, and broadcasts the message throughout the VLAN; thereby the multicast source in the VLAN knows the multicast member. When the multicast source sends packets to its group, the switch only forwards the packets to the ports connected to members, thereby implementing the Layer 2 multicast in VLAN.

The multicast information transmitted by GMRP includes, local static multicast registration information configured manually, and the multicast registration information dynamically registered by other switches.

Configuring GMRP

The main tasks in a GMRP configuration are described in the following sections:

- Enable/Disable GMRP Globally
- Enabling/Disabling GMRP on the Port
- Displaying and Debugging GMRP

In the configuration process, GMRP must be enabled globally before it is enabled on the port.

Enable/Disable GMRP Globally

Perform the following configuration in system view.

Table 46 Enabling/Disabling GMRP Globally

Operation	Command
Enable GMRP globally.	**gmrp**
Disable GMRP globally.	**undo gmrp**

By default, GMRP is disabled.

Enabling/Disabling GMRP on the Port

Perform the following configuration in Ethernet port view.

Table 47 Enabling/Disabling GMRP on the Port

Operation	Command
Enable GMRP on the port_	**gmrp**
Disable GMRP on the port_	**undo gmrp**

GMRP should be enabled globally before being enabled on a port.

By default, GMRP is disabled on the port.

Displaying and Debugging GMRP

After the previous configuration, execute the **display** command to display the GMRP configuration, and to verify the effect of the configuration.

Execute the **debugging** command in user view to debug GMRP configuration.

Table 48 Display and Debug GMRP

Operation	Command
Display GMRP statistics.	**display gmrp statistics** [**interface** *interface_list*]
Display GMRP global status.	**display gmrp status**
Enable GMRP debugging	**debugging gmrp**
Disable GMRP debugging	**undo debugging gmrp event**

Example: Configuring GMRP

Implement dynamic registration and an update of multicast information between switches.

Figure 11 GMRP Networking

Configure LS_A:

1 Enable GMRP globally.

```
[SW8800]gmrp
```

2 Enable GMRP on the port.

```
[SW8800]interface GigabitEthernet1/1/1
[SW8800-Ethernet1/1/1] gmrp
```

Configure LS_B:

1 Enable GMRP globally.

```
[SW8800]gmrp
```

2 Enable GMRP on the port.

```
[SW8800]interface GigabitEthernet1/1/1
[SW8800-Ethernet1/1/1] gmrp
```

7 QoS/ACL Operation

This chapter covers the following topics:

- ACL Overview
- Configuring ACLs
- Displaying and Debugging ACL Configurations
- ACL Configuration Example
- QoS Configuration
- Configuration Examples
- Configuring Logon User ACL Control

ACL Overview

The Access Control List (ACL) classifies the data packets with a series of matching rules, including source address, destination address and port number. The switch verifies the data packets with the rules in the ACL and decides to forward, prioritize, or discard them.

A series of matching rules are required for the network devices to identify the packets. After identifying the packets, the switch can permit or deny them to pass through according to the defined policy. The ACL is used to implement these functions.

The data packet matching rules, that are defined by ACL, can also be used in other cases requiring traffic classification, such as defining traffic classification for QoS.

An access control rule includes several statements. Different statements specify different ranges of packets. When matching a data packet with the access control rule, the issue of match-order arises.

ACLs Activated Directly on Hardware

ACLs can be delivered to hardware for traffic filtering and classification. In this case, the matching order of many sub-rules in an ACL is determined by hardware, not by a customized order.

ACLs are sent directly to hardware when referencing ACLs to provide for QoS functions and when filtering and forwarding packets with ACLs.

ACLs Referenced by Upper-level Modules

An ACL can be used to filter or classify the data transmitted by the software of the switch. The user can determine the match order of ACL's sub-rules. There are two match-orders: configuration, which follows the user-defined configuration order when matching the rule, and automatic, which follows the depth-first principle.

The depth-first principle puts the statement specifying the smallest range of addresses on the top of the list. For example, 129.102.1.1 0.0.0.0 specifies a host,

while 129.102.1.1 0.0.255.255 specifies the network segment 129.102.0.1 through 129.102.255.255. The host is listed first in the access control list. The specific standard is:

- For basic ACL statements, source address wildcards are compared directly. If the wildcards are the same, the configuration sequence is used.
- For the ACL based on the interface filter, the rule that is configured is listed at the end, while others follow the configuration sequence.
- For the advanced ACL, source address wildcards are compared first. If they are the same, then destination address wildcards are compared. For the same destination address wildcards, ranges of port numbers are compared and the smaller range is listed first. If the port numbers are in the same range, the configuration sequence is used.

After you specify the match-order of an access control rule, you cannot modify it later unless you delete all the contents and specify the match-order again.

This type of filtering includes ACLs cited by route policy function, ACLs used for controlling user logons, and so on.

ACLs Supported

The switch supports these types of ACLs:

- Number-based basic ACLs
- Name-based basic ACLs
- Number-based advanced ACLs
- Name-based advanced ACLs
- Number-based L2 ACLs
- Name-based L2 ACLs

The ranges for the ACLs available on the switch are listed in the following table.

Table 1 Requirements for ACLs

Item	Number range
Number-based basic ACL	2000~2999
Number-based advanced ACL	3000~3999
Number-based L2 ACL	4000~4999
Name-based basic ACL	-
Name-based advanced ACL	-
Name-based L2 ACL	--
Maximum sub-rules for an ACL	0~127
Maximum sub-rules for the switch (sum of the sub-rules of all ACLs)	

Configuring ACLs

3Com recommends that you perform ACL configuration tasks in the order of the following sections:

- Configuring Time Range
- Defining and Applying a Flow Template

- Defining ACLs
- Activating ACLs

3Com recommends you perform the configuration tasks in the order in which they appear in this section.

Configuring Time Range

The process of configuring a time-range includes configuring the hour-minute range, date range, and period range. The hour-minute range is expressed in the units of minutes and hour (hh:mm). The date range is expressed in the units of date, month, and year (MM-DD-YYYY). The periodic time range is expressed by the day of the week (Sunday through Saturday).

Perform the following configurations in system view.

Table 2 Configuring Time Range

Operation	Command
Create time range	**time-range** time-name { start-time **to** end-time days-of-the-week [**from** start-time start-date] [**to** end-time end-date] | **from** start-time start-date [**to** end-time end-date] | **to** end-time end-date }
Delete time range	**undo time-range** time-name [start-time **to** end-time days-of-the-week [**from** start-time start-date] [**to** end-time end-date] | **from** start-time start-date [**to** end-time end-date] | **to** end-time end-date]

When the *start-time* and *end-time* are not configured, they are set to define one day. The end time must be later than the start time.

When the *end-time end-date* is not configured, it will be all the time from now to the latest date that can be displayed by the system. The end time must be later than the start time.

Defining and Applying a Flow Template

Defining a Flow Template

A flow template defines useful information used in flow classification. For example, a template defines a quadruple: source and destination IP, source and destination TCP ports, and then only those traffic rules including all these elements can be sent to target hardware and referenced for such QoS functions as packet filtering, traffic policing, and priority re-labeling. Otherwise, the rules cannot be activated on the hardware and referenced.

Perform the following configurations in system view.

Table 3 Defining a Flow Template

Operation	Command
Define flow template	**flow-template user-defined** { template-info | **vpn** }
Delete flow template	**undo flow-template user-defined**

Note that the sum of all elements should be less than 16 bytes in length. The following table lists the length of the elements involved.

Table 4 Length of Template Elements

Name	Description	Length in template
dip	Destination IP field in IP packet header	4 bytes
dmac	Destination MAC field in Ethernet packet header	6 bytes
dport	Destination port field	2 bytes
dscp	DSCP field in IP packet header	1 byte
ip-precedence	P precedence field in IP packet header	
tos	ToS field in IP packet header	
ethernet-protocol	Protocol field in Ethernet packet header	2 bytes
icmp-code	ICMP code field	1 byte
icmp-type	ICMP type field	1 byte
ip-protocol	Protocol field in IP packet header	1 byte
sip	Source IP field in IP packet header	4 bytes
smac	MAC field in Ethernet packet header	6 bytes
sport	Source port field	2 bytes
tcp-flag	Flag field in TCP packet header	1 byte

The numbers listed in the table are not the actual length of these elements in IP packets, but their length in a flow template. DSCP field is one byte in a flow template, but six bytes in IP packets. You can judge the total length of template elements using these numbers.

The *dscp*, *ip-precedence* and *tos* fields jointly occupy one byte. One byte is occupied no matter you define one, two or three of these fields.

The fragment field is 0 in length in flow template, so it can be ignored in calculating the total length of template elements.

You can use the default template, which defines a quintuple: source and destination IP addresses, source and destination TCP/UDP ports, IP protocol. You may also define a flow template based on your needs.

You cannot modify or delete the default flow template.

Applying a Flow Template

Perform the following configurations in Ethernet port view or VLAN view to apply the user-defined flow template to current port or current VLAN.

Table 5 Applying a Flow Template

Operation	Command
Apply the user-defined flow template to current port or current VLAN	**flow-template user-defined**
cancel the applied flow template on current port or current VLAN	**undo flow-template user-defined**

Defining ACLs

The switch supports several types of ACLs, which are described in this section.

Follow these steps to define an ACL

1. Enter the corresponding ACL view
2. Define ACL rules. Note that:
   - If the time-range keyword is not selected, the ACL will be effective at any time after being activated.
   - You can define multiple rules for the ACL by using the rule command several times.
   - If the ACL is sent directly to hardware for packet filtering and traffic classification, the configuration matching order becomes ineffective. If the ACL is used in filtering or classifying the packets processed by software, the configuration matching order is available. You cannot modify the matching order once you define it for an ACL rule.
   - By default, ACL rules are matched in configuration order.

Defining Basic ACLs

Basic ACLs make rules and process packets according to the source IP addresses.

Perform the following configurations in the specified views.

Table 6 Defining Basic ACLs

Operation	Command
Enter basic ACL view (system view)	**acl { number** acl-number | **name** acl-name basic } [**match-order { config | auto** }]
Define an ACL rule (basic ACL view)	**rule** [rule-id] { **permit | deny** } [**source** { source-addr wildcard | **any** } | **fragment | time-range** name | **vpn-instance** instance-name]*
Delete an ACL rule (basic ACL view)	**undo rule** rule-id [**source | fragment | time-range | vpn-instance** instance-name]*
Delete an ACL or all ACLs (system view)	**undo acl { number** acl-number | **name** acl-name | **all** }

Defining Advanced ACLs

Advanced ACLs define classification rules and process packets according to the source and destination IP addresses, TCP/UDP ports, packet priority. ACLs support three types of priority schemes: ToS (type of service) priority, IP priority and DSCP priority.

Perform the following configurations in the specified view.

Table 7 Defining advanced ACL

Operation	Command
Enter advanced ACL view (system view)	**acl { number** acl-number | **name** acl-name **advanced } [match-order { config | auto }]**

Table 7 Defining advanced ACL

Operation	Command
Define an ACL rule (advanced ACL view)	**rule** [rule-id] { **permit | deny** } protocol [**source** { source-addr wildcard | **any** }] [**destination** { dest-addr wildcard | **any** }] [**source-port** operator port1 [port2]] [**destination-port** operator port1 [port2]] [**icmp-type** type code] [**established**] [[**precedence** precedence | **tos** tos]* | **dscp** dscp] [**fragment**] [**time-range** name] [**vpn-instance** instance-name]
Delete an ACL rule (advanced ACL view)	**undo rule** rule-id [**source** | **destination | source-port | destination-port | icmp-type | precedence | tos | dscp | fragment | time-range | vpn-instance]***
Delete an ACL or all ACLs (system view)	**undo acl { number** acl-number | **name** acl-name | **all** }

Note that the port1 and port2 parameters in the command should be TCP/UDP ports for advanced applications. For some common ports, you can use mnemonic symbols to replace numbers. For example, you can use "bgp" to represent TCP port 179, which is for BGP protocol.

Defining L2 ACLs

L2 ACLs define source and destination MAC addresses, source and destination VLAN IDs, L2 protocol type in their rules and process packets according to these attributes.

Perform the following configurations in the specified view.

Table 8 Defining L2 ACLs

Operation	Command
Enter L2 ACL view (system view)	**acl { number** acl-number | **name** acl-name **link } [match-order { config | auto** }]
Define an ACL rule (L2 ACL view)	**rule** [rule-id] { **permit | deny** } [protocol | **ingress** { { source-vlan-id | source-mac-addr source-mac-wildcard }* | **any } | egress** { dest-mac-addr dest-mac-wildcard | **any } | time-range** name]*
Delete an ACL rule (L2 ACL view)	**undo rule** rule-id
Delete an ACL or all ACLs (system view)	**undo acl { number** acl-number | **name** acl-name | **all** }

Activating ACLs

After you define an ACL, you must activate it. This configuration activates those ACLs to filter or classify the packets forwarded by hardware.

Perform the following configurations in Ethernet interface or VLAN view.

Table 9 Activating ACL

Operation	Command
Activate IP group ACL	**packet-filter inbound ip-group** { acl-number | acl-name } [**rule** rule [**system-index** index]]
Deactivate IP group ACL	**undo packet-filter inbound ip-group** { acl-number | acl-name } [**rule** rule]

Table 9 Activating ACL

Operation	Command
Activate IP group ACL and link group ACL at same time	**packet-filter inbound ip-group** { acl-number | acl-name } { **rule** rule link-group { acl-number | acl-name } [rule rule [**system-index** index]] | **link-group** { acl-number | acl-name } **rule** rule }
Deactivate IP group ACL and link group ACL at same time	**undo packet-filter inbound ip-group** { acl-number | acl-name } { **rule** rule **link-group** { acl-number | acl-name } [**rule** rule] | **link-group** { acl-number | acl-name } **rule** rule }
Activate link group ACL	**packet-filter inbound link-group** { acl-number | acl-name } [**rule** rule [**system-index** index]]
Deactivate link group ACL	**undo packet-filter inbound link-group** { acl-number | acl-name } [**rule** rule]

Displaying and Debugging ACL Configurations

After these configurations are completed, you can use the **display** command in any view to view ACL running to check configuration result. You can clear ACL statistics using the **display** command in user view.

Table 10 Displaying and debugging ACL configurations

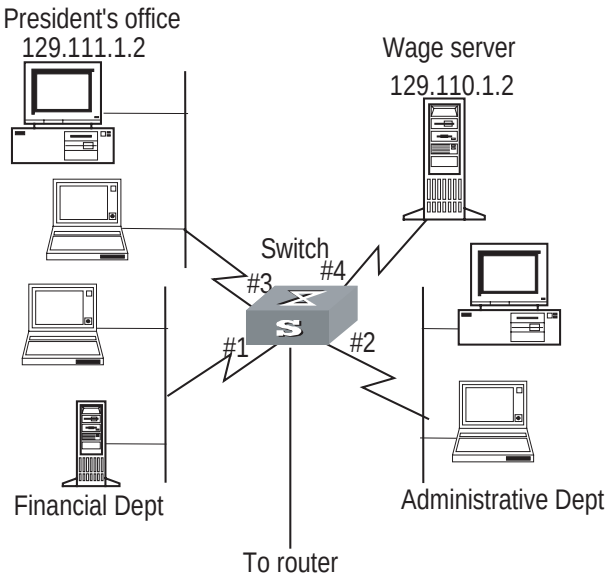
Operation	Command
Display time range configuration	**display time-range** { all | name }
Display ACL configuration	**display acl config** { all | acl-number | acl-name }
Display ACL application information	**display acl running-packet-filter { all | interface** { interface-name | interface-type interface-num } | **vlan** vlan-id }
Display configuration information of flow template	**display flow-template [default | interface** interface-type interface-num | **user-defined** | vlan vlan-id]
Clear ACL statistics	**reset acl counter** { all | acl-number | acl-name }

The **display acl config** command only displays the ACL matching information processed by the CPU. You can use the **display qos-interface traffic-statistic** command to view the ACL matching information during data forwarding.

ACL Configuration Example

The intranet is connected through 100 Mbps ports between departments. The wage server of the financial department is connected through the port GigabitEthernet7/1/1 (subnet address 129.110.1.2). With proper ACL configuration, the CEO's office can access the wage server at any time, but other departments can access it only at work time.

Figure 1 Networking for advanced ACL configuration



Only the commands concerning ACL configuration are listed here.

1 Define the time range from 8:00 to 18:00.

```
[SW8800]time-range 3com 8:00 to 18:00 working-day
```

2 Define inbound traffic to the wage server.

Create a name-based advanced ACL "traffic-of-payserver" and enter it.

```
[SW8800]acl name traffic-of-payserver advanced
```

Define ACL rule for other departments.

```
[SW8800-acl-adv-traffic-of-payserver]rule 1 deny ip source any
destination 129.110.1.2 0.0.0.0 time-range 3com
```

Define an ACL rule for CEO's office.

```
[SW8800-acl-adv-traffic-of-payserver]rule 2 permit ip source
129.111.1.2 0.0.0.0 destination 129.110.1.2 0.0.0.0
```

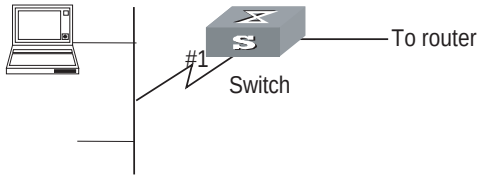
3 Activate the ACL "traffic-of-payserver".

```
[SW8800-GigabitEthernet2/1/1]packet-filter inbound ip-group
traffic-of-payserver
```

Basic ACL Configuration Example

With proper basic ACL configuration, during the time range from 8:00 to 18:00 everyday the switch filters the packets from the host with source IP 10.1.1.1 (the host is connected through the port GigabitEthernet2/1/1 to the switch.)

Figure 2 Networking for basic ACL configuration



Only the commands concerning ACL configuration are listed.

1 Define the time range from 8:00 to 18:00.

```
[SW8800]time-range 3com 8:00 to 18:00 daily
```

2 Define the traffic with source IP 10.1.1.1.

Create a name-based basic ACL "traffic-of-host" and enter it.

```
[SW8800]acl name traffic-of-host basic
```

Define ACL rule for source IP 10.1.1.1.

```
[SW8800-acl-basic-traffic-of-host]rule 1 deny ip source 10.1.1.1 0
time-range 3com
```

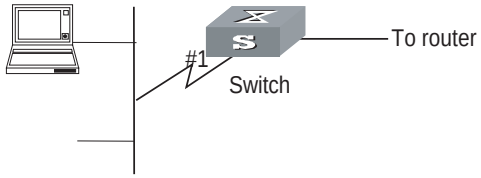
3 Activate the ACL "traffic-of-host".

```
[SW8800-GigabitEthernet2/1/1]packet-filter inbound ip-group
traffic-of-host
```

L2 ACL Configuration Example

With proper L2 ACL configuration, during the time range from 8:00 to 18:00 everyday the switch filters the packets with source MAC 00e0-fc01-0101 and destination MAC 00e0-fc01-0303 (configuring at the port GigabitEthernet2/1/1 to the switch.)

Figure 3 Networking for L2 ACL Configuration



Only the commands concerning ACL configuration are listed.

1 Define the time range from 8:00 to 18:00.

```
[SW8800]time-range 3com 8:00 to 18:00 daily
```

2 Define the traffic with source MAC 00e0-fc01-0101 and destination MAC 00e0-fc01-0303.

Create a name-based L2 ACL "traffic-of-link" and enter it.

```
[SW8800]acl name traffic-of-link link
```

Define ACL rule for the traffic with source MAC 00e0-fc01-0101 and destination MAC 00e0-fc01-0303.

```
[SW8800-acl-link-traffic-of-link]rule 1 deny ingress 00e0-fc01-0101
0-0-0 egress 00e0-fc01-0303 0-0-0 time-range 3com
```

3 Activate the ACL "traffic-of-host".

```
[SW8800-GigabitEthernet2/1/1]packet-filter inbound link-group
traffic-of-link
```

QoS Configuration

In a traditional IP network, all packets are treated equally without priority difference. Every switch or router handles the packets following the first-in first-out (FIFO) policy. Switches and routers make their best effort to transmit the packets to the destination, not making any commitment or guarantee of the transmission reliability, delay, or to satisfy other performance requirements.

Ethernet technology is currently the most widely used network technology. Ethernet has been the dominant technology of various independent Local Area Networks (LANs), and many Ethernet LANs have been part of the Internet. To implement the end-to-end QoS solution on the whole network, one must consider how to guarantee Ethernet QoS service. This requires the Ethernet switching devices to apply Ethernet QoS technology and deliver the QoS guarantee at different levels to different types of signal transmissions over the networks, especially those having requirements of shorter time delay and lower jitter.

The following sections describe terms and concepts used when configuring QoS:

Flow

It refers to all packets passing thought the switch.

Traffic classification

Traffic classification is the technology that identifies the packets with a specified attribute according to a specific rule. Classification rule refers to a packet filtering rule configured by an administrator. A classification rule can be very simple. For example, the switch can identify the packets of different priority levels according to the ToS (type of service) field in the packet headers. It can also be very complex. For example, it may contain information of the link layer (layer 2), network layer (layer 3) and transport layer (layer 4) and the switch classifies packets according to such information as MAC address, IP protocol, source address, destination address and port ID. Classification rule often is limited to the information encapsulated at the packet header, rarely using packet contents.

Packet filtering

Packet filtering refers to filtering operation applied to traffic flow. For example, the deny operation drops the traffic flow which matches the classification rule and allows other traffic to pass. Switches use complex classification rules, so that traffic flow can be filtered by varied information, to enhance network security.

There are two key steps in achieving packet filtering:

- Classify the traffic at the port according to a specific rule.

- Run the filtering operation (deny or permit) to the identified traffic. The default filtering operation is to deny traffic.

Traffic policing

QoS can police traffic at the ingress port, to provide better services with the limited network resources.

Redirection

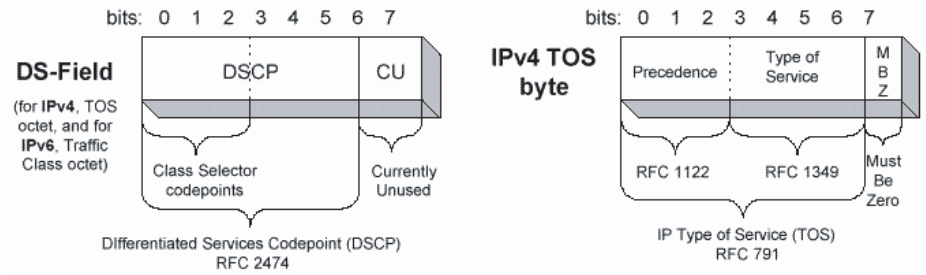
You can re-specify forwarding port for packets, based on QoS policy.

Traffic priority

Switches can provide priority tags, including ToS, DSCP, 802.1p, and so on, for specific packets. These priority tags are applicable to different QoS models.

Figure 4 illustrates the DS field and TOS byte.

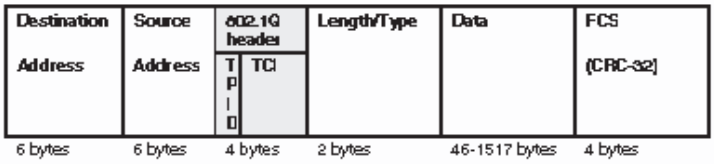
Figure 4 DS Field and ToS Byte



As shown in Figure 4, the ToS field in the IP header contains 8 bits. The first three bits represent IP priority, in the range of 0 to 7; bits 3-6 stand for ToS priority, in the range of 0 to 15. RFC2474 redefines the ToS field in IP packets as DS (differentiated services) field. The first six bits denote DSCP (differentiated services codepoint) priority, in the range of 0 to 63, the latter two bits are reserved.

802.1p priority is stored in the header of L2 packets and is suitable for a case in which only L2 QoS guarantee, not L3 header analysis, is required. Figure 5 illustrates an Ethernet frame with the 802.1Q tag header.

Figure 5 Ethernet Frame with 802.1Q Tag Header

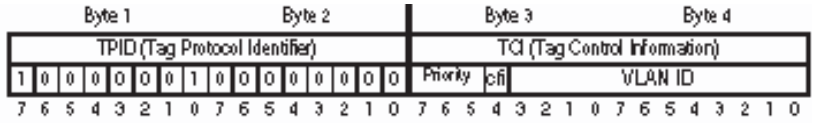


In Figure 5, each host supporting 802.1Q protocol adds a 4-byte 802.1Q tag header after the source address in Ethernet header.

The 802.1Q tag header contains a 2-byte TPID (Tag protocol Identifier, with the value 8100) and a 2-byte TCI (tag control information). TPID is newly defined by

IEEE to represent a packet with 802.1Q tag added. The contents of 802.1Q tag header are shown in Figure 6.

Figure 6 802.1Q Tag Header



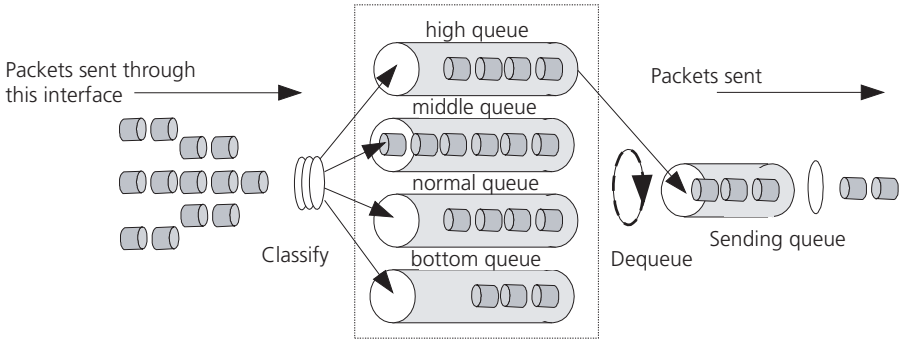
In the figure, the priority field in TCI stands for 802.1p priority, which consists of three bits. There are eight priority levels, numbered as 0 to 7, for determining which packets to send first when switch congestion takes place.

Since their applications are defined in detail in the 802.1p Recommendation, they are named as 802.1p priority levels.

Queue Scheduling

Queue scheduling is used to resolve problems of resource contention by many packets. The strict priority (SP) and weighted round robin (WRR) algorithms are often used in queue scheduling.

Figure 7 Priority Queues



SP algorithm The SP algorithm is designed for key services. One of the characteristics of key services is these services should be processed first to minimize response delay during switch congestion. For example, there are eight outbound queues at the port, numbered respectively as 7~0, with priority levels in descending order.

In SP mode, the system first sends those packets of higher priority in strict accordance with priority order. Only when packets in high priority queue are all sent can those in lower priority queue be sent. This manner of putting key-service packets into high priority queue and non-key service packets into low priority queue does ensure that key-service packets are sent first, while non-key service packets are sent during the interval when no key-service packets needs to be processed.

SP algorithm also has its disadvantages: If high priority queues always have packets for a long period, then the packets in low queues may die of hunger for being processed.

WRR algorithm Each port supports four or eight outbound queues. In WRR mode, the system processes the queues by turn, so every queue can have a service period.

See the case where the port supports four outbound queues. Every queue is assigned with a weight value (respectively numbered as w3, w2, w1 and w0), which indicates the weight in obtaining resources. For a 100 Mbps port, the weight values are set as 50, 30, 10 and 10 (corresponding respectively to w3, w2, w1 and w0). The even the queue with the lowest priority can be allocated with a 10 Mbps bandwidth.

Another merit for WRR algorithm: Though the queues are scheduled by turn, they are not configured with fixed time quantum. If a queue has no packets, the system immediately schedules the next queue. Then bandwidth resources can be fully utilized.

Traffic mirroring

Traffic mirroring duplicates specified packets to the monitoring port for network test and troubleshooting.

Port mirroring

Port mirroring duplicates all packets at a specified port to the monitoring port for network test and troubleshooting.

Flow-based traffic statistics

The system can make traffic statistics based on flow for further analysis.

QoS Configuration

QoS configuration tasks include

- Configuring Packet Filtering
- Configuring the Service Parameter Allocation Rule
- Configuring Traffic Policing
- Configuring Mapping Tables
- Configuring Traffic Shaping
- Configuring Traffic Priority
- Configuring Traffic Redirection
- Configuring Queue Scheduling
- Configuring WRED Parameters
- Configuring the Drop Algorithm
- Configuring Traffic Mirroring
- Configuring Port Mirroring
- Configuring Traffic Statistics
- Displaying and Debugging the QoS Configuration

Configuring Packet Filtering

Before initiating any of these QoS configuration tasks, you should first define the corresponding ACL. Then you can achieve packet filtering just by activating the right ACL.

Some of QoS terms are listed in the following table.

Table 11 QoS Terms

Term	Description
CoS	Means the same as 802.1p priority. Both refer to the priority at packet header, with the value ranging from 0 to 7.
Service parameters	Switch allocates a set of parameters, which are used in achieving QoS functions, upon receiving a packet. Four items are included: 802.1p priority, DSCP priority, local precedence and drop precedence.
Drop-precedence	One of the service parameters, ranging from 0 to 2. Drop precedence is allocated when the switch receives the packet and may be when the packet is processed. Allocating drop precedence to the packet is also called coloring the packet: the packet with drop precedence 2 as red, that with drop precedence 1 as yellow and that with drop precedence 0 as green. Drop precedence is referred to when switch needs to drop packets when it is congested
Conform-level	The result calculated by the user-defined CIR, CBS, EBS, PIR and actual traffic when the switch runs traffic policing, in the range of 0 to 2. It is used as a parameter in the **traffic-limit** command (here the value depends on the calculated result). It is also involved in the DSCP + Conform level —> Service parameter mapping table which is used in re-allocating service parameters to a packet with the **traffic-priority** command. Then Conform-Level must be 0.

Configuring the Service Parameter Allocation Rule

QoS is based on service parameters, a set of parameters for a packet, including 802.1p priority (CoS priority), DSCP priority, local precedence and drop precedence.

After receiving a packet, the switch allocates a set of service parameters to it according to a specific rule. The switch first gets its local precedence and drop precedence according to the packet 802.1p priority value, by searching in the CoS -> Local-precedence mapping table and the CoS -> Drop-precedence mapping table. Default values are available for the two mapping tables, but you can also configure the mapping tables according to your needs. If the switch cannot allocate local precedence for the packet, it uses the default local precedence of the port for the packet. After obtaining packet local precedence, the switch then gets drop precedence according to the CoS -> Drop-precedence mapping table (local precedence value is used as CoS value in this process).

Configuring the Mapping Table Perform the following configurations in system view.

Table 12 Configuring Mapping Tables

Operation	Command
Configure the CoS -> Drop-precedence mapping table	**qos cos-drop-precedence-map** cos0-map-drop-prec cos1-map-drop-prec cos2-map-drop-prec cos3-map-drop-prec cos4-map-drop-prec cos5-map-drop-prec cos6-map-drop-prec cos7-map-drop-prec

Table 12 Configuring Mapping Tables

Operation	Command
Restore the default values of CoS -> Drop-precedence mapping table	**undo qos cos-drop-precedence-map**
Configure the CoS -> Local-precedence mapping table	**qos cos-local-precedence-map** cos0-map-local-prec cos1-map-local-prec cos2-map-local-prec cos3-map-local-prec cos4-map-local-prec cos5-map-local-prec cos6-map-local-prec cos7-map-local-prec
Restore the default values of CoS -> Local-precedence mapping table	**undo qos cos-local-precedence-map**

By default, the switch obtains local precedence and drop precedence according to the default mapping values.

Configuring Default Local Precedence for a Port Perform the following configuration in Ethernet interface view.

Table 13 Configuring Default Local Precedence for a Port

Operation	Command
Configuring default local precedence for a port	priority priority-level
Restore the default value	undo priority

Configuring Traffic Policing

Traffic policing refers to the rate limit based on traffic. If the traffic threshold is exceeded, corresponding measures will be taken, for example, dropping the excessive packets or re-defining their priority levels.

In the traffic supervision action, the switch uses the service parameters allocated according to the DSCP + Conform-Level -> Service parameter mapping table and the 802.1p priority values allocated according to the Local-precedence + Conform-Level -> 802.1p priority mapping table. So you should configure these two mapping tables or use their default values.

Perform the following configurations in Ethernet interface or VLAN view.

Table 14 Configuring Traffic Policing

Operation	Command
Configure traffic policing which only applies IP group ACL	traffic-limit inbound ip-group { acl-number | acl-name } [rule rule [system-index index]] [tc-index index] cir cbs ebs [pir] [conform { { remark-cos | remark-drop-priority }* | remark-policed-service }] [exceed { forward | drop }]
Remove traffic policing setting which only applies IP group ACL	undo traffic-limit inbound ip-group { acl-number | acl-name } [rule rule]
Configure traffic policing which applies IP group ACL and link group ACL at same time	traffic-limit inbound ip-group { acl-number | acl-name } { rule rule link-group { acl-number | acl-name } [rule rule [system-index index]] | link-group { acl-number | acl-name } rule rule } [tc-index index] cir cbs ebs [pir] [conform { { remark-cos | remark-drop-priority }* | remark-policed-service }] [exceed { forward | drop }]

Table 14 Configuring Traffic Policing

Operation	Command
Remove traffic policing setting which applies IP group ACL and link group ACL at same time	undo traffic-limit inbound ip-group { acl-number | acl-name } { rule rule link-group { acl-number | acl-name } [rule rule] | link-group { acl-number | acl-name } rule rule }
Configure traffic policing which only applies link group ACL	traffic-limit inbound link-group { acl-number | acl-name } [rule rule [system-index index]] [tc-index index] cir cbs ebs [pir] [conform { { remark-cos | remark-drop-priority }* | remark-policed-service }] [exceed { forward | drop }]
Remove traffic policing setting which only applies link group ACL	undo traffic-limit inbound link-group { acl-number | acl-name } [rule rule]

You must first define the corresponding ACL and configure the DSCP + Conform-Level -> Service parameters mapping table and Local-precedence + Conform-Level -> mapping table before beginning this configuration.

This configuration achieves traffic policing for the packets that match the ACL. If the traffic rate threshold is exceeded, corresponding measures will be taken, for example, dropping excessive packets.

See the *Switch 8800 Command Reference Guide* for details of the commands.

Configuring Mapping Tables

Perform the following configurations in the specified views.

Table 15 Configuring Mapping Tables

Operation	Command
Enter conform level view (System view)	**qos conform-level** conform-level-value
Configure the DSCP + Conform-Level -> Service parameters mapping table (conform level view)	**dscp** dscp-list : dscp-value exp-value cos-value local-precedence-value drop-precedence
Restore the default values of the DSCP + Conform-Level -> Service parameters mapping table (conform level view)	**undo dscp** dscp-list
Configure the EXP + Conform-Level -> Service parameters mapping table (conform level view)	**exp** exp-list : dscp-value exp-value cos-value local-precedence-value drop-precedence
Restore the default values of the EXP + Conform-Level -> Service parameters mapping table (conform level view)	**undo exp** exp-list
Configure the Local-precedence + Conform-Level -> mapping table (conform level view)	l**ocal-precedence** cos-value0 cos-value1 cos-value2 cos-value3 cos-value4 cos-value5 cos-value6 cos-value7
Restore the default values of the Local-precedence + Conform-Level -> mapping table (conform level view)	**undo local-precedence**

The system provides default mapping tables.

Configuring Traffic Shaping

Traffic shaping controls the rate of outbound packets, to ensure they are sent at relatively average rates. Traffic shaping measure tries to match packet transmission

rate with the capacity of downstream devices. Its major difference from traffic policing is: Traffic shaping buffers packets at over-threshold rates to make them sent at average rates, while traffic policing drops excessive packets. Therefore, traffic shaping may increase transmission delay, but not for traffic policing.

Perform the following configurations in Ethernet interface view.

Table 16 Configuring Traffic Shaping

Operation	Command
Configure traffic shaping	**traffic-shape [queue** queue-id] max-rate burst-size
Remove traffic shaping setting	**undo traffic-shape [queue** queue-id]

The switch supports traffic shaping based on the port, that is, all traffic on the port is shaped. It also supports traffic shaping for a specific queue. You can choose to achieve one of them by selecting different parameters in the command.

See the *Switch 8800 Command Reference Guide* for details of the commands.

Configuring Traffic Priority

This configuration re-labels priority value for the packets that match the ACL. The switch may allocate new service parameters by searching the mapping tables according to the DSCP values. You can customize a set of service parameters.

Perform the following configurations in Ethernet interface or VLAN view.

Table 17 Configuring Traffic Priority

Operation	Command
Configure traffic priority which only applies IP group ACL	**traffic-priority inbound ip-group** { acl-number | acl-name } [**rule** rule [**system-index** index]] { **auto** | **remark-policed-service { trust-dscp | dscp** dscp-value | **untrusted dscp** dscp-value cos cos-value **local-precedence** local-precedence **drop-priority** drop-level } }
Remove traffic priority setting which only applies IP group ACL	**undo traffic-priority inbound ip-group** { acl-number | acl-name } [**rule** rule]
Configure traffic priority which applies IP group ACL and link group ACL at same time	**traffic-priority inbound ip-group** { acl-number | acl-name } { **rule** rule **link-group** { acl-number | acl-name } [**rule** rule [**system-index** index]] | l**ink-group** { acl-number | acl-name } **rule** rule } { **auto** | **remark-policed-service { trust-dscp | dscp** dscp-value | **untrusted dscp** dscp-value **cos** cos-value **local-precedence** local-precedence **drop-priority** drop-level } }
Remove traffic priority setting which applies IP group ACL and link group ACL at same time	**undo traffic-priority inbound ip-group** { acl-number | acl-name } { **rule** rule **link-group** { acl-number | acl-name } [**rule** rule] | **link-group** { acl-number | acl-name } **rule** rule }
Configure traffic priority which only applies link group ACL	**traffic-priority inbound link-group** { acl-number | acl-name } [**rule** rule [**system-index** index]] { **auto | remark-policed-service { trust-dscp | dscp** dscp-value | **untrusted dscp** dscp-value cos cos-value **local-precedence** local-precedence **drop-priority** drop-level } }

Table 17 Configuring Traffic Priority

Operation	Command
Remove traffic priority setting which only applies link group ACL	**undo traffic-priority inbound link-group** { acl-number | acl-name } [rule rule]

You must first define the corresponding ACL and configure the DSCP + Conform-Level -> Service parameters mapping table before starting this configuration.

The DSCP + Conform-Level 0 -> Service parameters mapping table (the mapping table for conform level 0) is used here.

See the *Switch 8800 Command Reference Guide* for details of the commands.

Configuring Traffic Redirection

Traffic redirection changes the packet forwarding direction, to CPU, other ports, other IP or segment addresses.

Perform the following configurations in Ethernet interface or VLAN view.

Table 18 Configuring Traffic Redirection

Operation	Command
Configure traffic redirection which only applies IP group ACL	t**raffic-redirect inbound ip-group** { acl-number | acl-name } [**rule** rule [**system-index** index]] { **cpu | interface** { interface-name | interface-type interface-num } destination-vlan { l**2-vpn | l3-vpn** } | **next-hop** ip-addr1 ip-addr2 }
Remove traffic redirection setting which only applies IP group ACL	**undo traffic-redirect inbound ip-group** { acl-number | acl-name } [**rule** rule]
Configure traffic redirection which applies IP group ACL and link group ACL at same time	t**raffic-redirect inbound ip-group** { acl-number | acl-name } { **rule** rule **link-group** { acl-number | acl-name } [**rule** rule [**system-index** index]] | **link-group** { acl-number | acl-name } **rule** rule } { cpu | **interface** { interface-name | interface-type interface-num } destination-vlan { **l2-vpn | l3-vpn } | next-hop** ip-addr1 ip-addr2 }
Remove traffic redirection setting which applies IP group ACL and link group ACL at same time	**undo traffic-redirect inbound ip-group** { acl-number | acl-name } { **rule** rule **link-group** { acl-number | acl-name } [**rule** rule] | **link-group** { acl-number | acl-name } **rule** rule }
Configure traffic redirection which only applies link group ACL	**traffic-redirect inbound link-group** { acl-number | acl-name } [**rule** rule [**system-index** index]] { **cpu | interface** { interface-name | interface-type interface-num } destination-vlan { **l2-vpn | l3-vpn } | next-hop** ip-addr1 [ip-addr2] }
Remove traffic redirection setting which only applies link group ACL	**undo traffic-redirect inbound link-group** { acl-number | acl-name } [**rule** rule]

Traffic redirection setting is only available for the permitted rules in the ACL.

The packet redirected to the CPU cannot be forwarded normally.

You can achieve policy route by selecting the next-hop keyword.

See the *Switch 8800 Command Reference Guide* for details of the commands.

Configuring Queue Scheduling

The switch supports eight outbound queues at a port and it puts the packets into the queues according to the local precedence of packets. Queue scheduling is used to resolve problems of resource contention by many packets. The switch supports SP algorithm and WRR algorithm.

Different outbound queues at the port can use different algorithms. The switch supports three scheduling modes:

- All-SP scheduling
- All-WRR: The outbound queues are divided into WRR queue 1 and WRR queue 2. The switch first schedules the queues in the WRR queue1. If no packets are waiting for being forwarded in WRR queue 1, then it begins to schedule the queues in WRR queue 2. By default, all queues at a port are in WRR queue 1.
- SP plus WRR: The outbound queues are put into different scheduling groups. An SP group uses SP algorithm, WRR groups use WRR algorithm. The select one queue respectively from SP group, WRR group 1 and WRR group 2 and schedule them using the SP algorithm.

Perform the following configurations in Ethernet interface view.

Table 19 Configuring Queue Scheduling

Operation	Command
Configuring queue scheduling	**queue-scheduler wrr { group1** { queue-id queue-weight } &<1-8> | **group2** { queue-id queue-weight } &<1-8> }*
Restore the default setting	**undo queue-scheduler** [queue-id] &<1-8>

By default, the switch uses all-SP mode, so those queues not configured with WRR algorithm are SP mode.

See the *Switch 8800 Command Reference Guide* for details of the commands.

Configuring WRED Parameters

When there is network congestion, the switch drops packets to release system resources so no packets are put into long-delay queues.

The switch allocates drop precedence for it when receiving a packet (also called coloring the packet). The drop precedence values range from 0 to 2, with 2 for red, 1 for yellow and 0 for green. In congestion, red packets will be first dropped, and green packets last.

You can configure drop parameters and thresholds by queue or drop precedence.

The following two drop modes are available:

- Tail drop mode: Different queues (red, yellow and red) are allocated with different drop thresholds. When these thresholds are exceeded respectively, excessive packets will be dropped.
- WRED drop mode: Drop precedence is taken into account in drop action. When only min-thresholds of red, yellow and green packets are exceeded, excessive packets are dropped randomly at given probability. But when

max-thresholds of red, yellow and green packets are exceeded, all excessive packets are dropped.

You must first configure WRED parameters for every outbound queue in defining drop precedence.

The switch provides four sets of default WRED parameters, respectively numbered as 0 to 3. Each set includes 80 parameters, 10 parameters for each of the eight queues. The ten parameters are green-min-threshhold, yellow-min-threshhold, red-min-threshhold, green-max-threshhold, yellow-max-threshhold, red-max-threshhold, green-max-prob, yellow-max-prob, red-max-prob and exponent. Red, yellow and green packets respectively refer to those with drop precedence levels 2, 1 and 0.

Perform the following configurations in the specified views.

Table 20 Configuring WRED parameters

Operation	Command
Enter WRED index view (system view)	**wred** wred-index
Restore the default WRED parameters (system view)	**undo wred** wred-index
Configure WRED parameters (WRED index view)	**queue** queue-id green-min-threshold green-max-threshold green-max-prob yellow-min-threshold yellow-max-threshold yellow-max-prob red-min-threshold red-max-threshold red-max-prob exponent
Restore the default WRED parameters (WRED index)	**undo queue** queue-id
Exit WRED index view (WRED index view)	**quit**

The command restores the parameters of the specified WRED index as the default setting. The command restores the WRED parameters related to the queue as the default setting.

The switch provides four sets of WRED parameters by default.

See the *Switch 8800 Command Reference Guide* for details of the commands.

Configuring the Drop Algorithm

Perform the following configurations in Ethernet port view.

Table 21 Configuring the Drop Algorithm

Operation	Command
Configure drop algorithm	**drop-mode { tail-drop | wred** } [wred-index]
Restore the default algorithm	**undo drop-mode**

By default, tail drop mode is selected.

See the corresponding Command Manual for details of the commands.

Configuring Traffic Mirroring

Traffic mirroring duplicates the traffic that matches ACL rules to the CPU, for traffic analysis and monitoring.

Perform the following configurations in Ethernet interface or VLAN view.

Table 22 Configuring Traffic Mirroring

Operation	Command
Configure traffic mirroring which only applies IP group ACL	**mirrored-to inbound ip-group** { acl-number | acl-name } [**rule** rule [**system-index** index]] **cpu**
Remove traffic mirroring setting which only applies IP group ACL	**undo mirrored-to inbound ip-group** { acl-number | acl-name } [**rule** rule]
Configure traffic mirroring which applies IP group ACL and link group ACL at same time	**mirrored-to inbound ip-group** { acl-number | acl-name } { **rule** rule **link-group** { acl-number | acl-name } [**rule** rule [**system-index** index]] | **link-group** { acl-number | acl-name } **rule** rule } **cpu**
Remove traffic mirroring setting which applies IP group ACL and link group ACL at same time	**undo mirrored-to inbound ip-group** { acl-number | acl-name } { **rule** rule **link-group** { acl-number | acl-name } [**rule** rule] | **link-group** { acl-number | acl-name } **rule** rule }
Configure traffic mirroring which only applies link group ACL	**mirrored-to inbound link-group** { acl-number | acl-name } [**rule** rule [**system-index** index]] **cpu**
Remove traffic mirroring setting which only applies link group ACL	**undo mirrored-to inbound link-group** { acl-number | acl-name } [**rule** rule]

See the *Switch 8800 Command Reference Guide* for details of the commands.

Configuring Port Mirroring

Port mirroring duplicates data on the monitored port to the designated monitoring port, for purpose of data analysis and supervision. The switch supports multiple-to-one mirroring, that is, you can duplicate packets from multiple ports to a monitoring port.

You can also specify the monitoring direction:

- Only inbound packets
- Only outbound packets

Perform the following configurations in system view.

Table 23 Configuring Port Mirroring

Operation	Command
Configure port mirroring	**mirroring-group** groupId { **inbound | outbound** } mirroring-port-list &<1-8> **mirrored-to** mornitor-port
Remove port mirroring setting	**undo mirroring-group** groupId

You can implement a port mirroring configuration by setting mirroring groups at the port. Up to 20 mirroring groups can be configured at a port, with each group including one monitoring port and multiple monitored ports.

The limit of port mirroring configuration:

- The monitor port and the monitored ports must be the ports in the same interface card.
- Only one mirror group can be configured on one interface card for one direction mirror. For example, only one inbound direction mirror group can be configured on an interface card. If user configures another inbound direction mirror group, the system will give configure failure prompt. So does the outbound direction mirror group.

See the *Switch 8800 Command Reference Guide* for details of the commands.

Configuring Traffic Statistics

Traffic statistics count packets of designated service traffic, that is, the packets match the defined ACL among those forwarded. You can view the information with the display qos-interface traffic-statistic command.

Perform the following configurations in Ethernet port or VLAN view.

Table 24 Configuring traffic statistics

Operation	Command
Configure traffic statistics which only applies IP group ACL	**traffic-statistic inbound ip-group** { acl-number | acl-name } [**rule** rule [**system-index** index]] [**tc-index** index]
Remove traffic statistics setting which only applies IP group ACL	**undo traffic-statistic inbound ip-group** { acl-number | acl-name } [**rule** rule]
Configure traffic statistics which applies IP group ACL and link group ACL at same time	**traffic-statistic inbound ip-group** { acl-number | acl-name } { **rule** rule **link-group** { acl-number | acl-name } [**rule** rule [**system-index** index]] | **link-group** { acl-number | acl-name } **rule** rule } [**tc-index** index]
Remove traffic statistics setting which applies IP group ACL and link group ACL at same time	**undo traffic-statistic inbound ip-group** { acl-number | acl-name } { **rule** rule **link-group** { acl-number | acl-name } [**rule** rule] | **link-group** { acl-number | acl-name } **rule** rule }
Configure traffic statistics which only applies link group ACL	**traffic-statistic inbound link-group** { acl-number | acl-name } [**rule** rule [**system-index** index]] [**tc-index** index]
Remove traffic statistics setting which only applies link group ACL	**undo traffic-statistic inbound link-group** { acl-number | acl-name } [**rule** rule]
Display traffic statistics for the port	**display qos-interface** [interface-name | interface-type interface-num] **traffic-statistic**

See the *Switch 8800 Command Reference Guide* for details of the commands.

Displaying and Debugging the QoS Configuration

After these configurations are completed, you can use the display command in any view to view QoS running and check configuration result. You can clear QoS statistics using the display command in Ethernet interface view.

Table 25 Displaying and Debugging QoS Configurations

Operation	Command
Display configuration of QoS actions	**display qos-global all**
Display traffic mirroring configuration of a port	**display qos-interface** [interface-name | interface-type interface-num] **mirrored-to**

Table 25 Displaying and Debugging QoS Configurations

Operation	Command
Display traffic priority configuration of a port	**display qos-interface** [interface-name | interface-type interface-num] **traffic-priority**
Display traffic redirection configuration of a port	**display qos-interface** [interface-name | interface-type interface-num] **traffic-redirect**
Display traffic statistics of a port	**display qos-interface** [interface-name | interface-type interface-num] **traffic-statistic**
Display port mirroring configuration	**display mirroring-group** [groupid]
Display QoS configurations of all ports	**display qos-interface** [interface-name | interface-type interface-num] **all**
Display traffic limit configuration of a port	**display qos-interface** [interface-name | interface-type interface-num] **traffic-limit**
Display queue scheduling configuration of a port	**display qos-interface** [interface-name | interface-type interface-num] **queue-scheduler**
Display traffic shaping configuration of a port	**display qos-interface** [interface-name | interface-type interface-num] **traffic-shape**
Display the DSCP + Conform-level -> Service parameter and Local-precedence + Conform-level -> 802.1p priority mapping tables	**display qos conform-level** [conform-level-value] { **dscp-policed-service-map** [dscp-list] | **local-precedence-cos-map** }
Display the COS -> Drop-precedence mapping table	**display qos cos-drop-precedence-map**
Display the COS -> Local-precedence mapping table	**display qos cos-local-precedence-map**
Clear traffic statistics	**reset traffic-statistic inbound** { { **ip-group** { acl-number | acl-name } **rule** rule | link-group { acl-number | acl-name } }* | { **ip-group** { acl-number | acl-name } | **link-group** { acl-number | acl-name } rule rule }* | **ip-group** { acl-number | acl-name } **rule** rule **link-group** { acl-number | acl-name } **rule** rule }

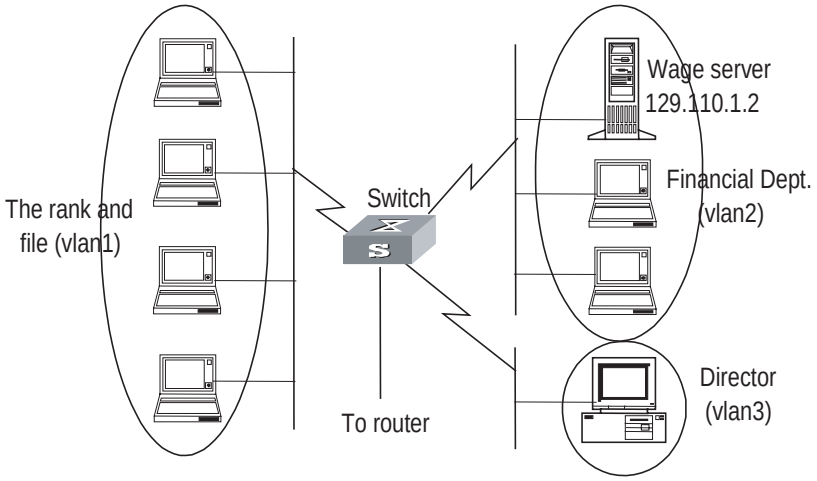
See the *Switch 8800 Command Reference Guide* for a description of display information and parameters.

Configuration Examples

Traffic Policing Configuration Example

The intranet is connected through 100 Mbps ports between departments and the wage server is assigned with the IP address 129.110.1.2. The rank and file (VLAN 1) cannot access the wage server during work time (08:30 to 18:00), but other departments are not limited by this condition. For the wage server, the CIR is 100 kbps, CSB is 2000 bytes and EBS is 3000 bytes.

Figure 8 Networking for traffic policing configuration



Only the commands concerning QoS/ACL configuration are listed here.

1 Define the time range "worktime" in system view.

```
[SW8800]time-range worktime 08:30 to 18:00 working-day
```

2 Define the traffic to the wage server.

Create a name-based advanced ACL "traffic-to-payserver" and enter it.

```
[SW8800]acl name traffic-to-payserver advanced
```

Define rules for the "traffic-to-payserver" ACL.

```
[SW8800-acl-adv-traffic-to-payserver]rule 1 deny ip destination
129.110.1.2 0 time-range worktime
```

3 Define the traffic from the wage server.

Create a name-based advanced ACL "traffic-from-payserver" and enter it.

```
[SW8800]acl name traffic-from-payserver advanced
```

Define rules for the "traffic-from-payserver" ACL.

```
[SW8800-acl-adv-traffic-from-payserver]rule 1 permit ip source
129.110.1.2 0
```

4 Limit the rank-and-file's access to the wage server.

The rank-and-file cannot access the wage server during work time, but not limited at other time. Other groups are also not limited.

```
[SW8800-vlan1]packet-filter inbound ip-group traffic-to-payserver
rule 1
```

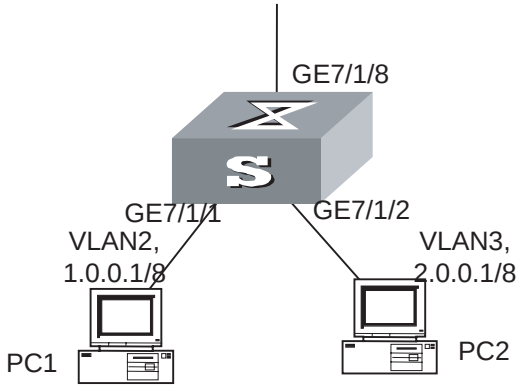
5 Limit outbound traffic from the wage server: CIR is 100 kbps, CBS is 2000 bytes and EBS is 3000 bytes.

```
[SW8800-vlan2]traffic-limit inbound ip-group traffic-from-payserver
rule 1 100 2000 3000
```

Traffic Shaping Configuration Example

Set traffic shaping for the outbound queue 2 at the port GE7/1/8: maximum rate 500kbps, burst size 12k bytes.

Figure 9 Networking for QoS Configuration



1 Enter Ethernet interface GigabitEthernet7/1/8 view.

```
[SW8800]interface GigabitEthernet7/1/8
[SW8800-GigabitEthernet7/1/8]
```

2 Set traffic shaping for the outbound queue 2 at the port: maximum rate 650kbps, burst size 8kbytes, maximum queue length 80kbytes.

```
[SW8800-GigabitEthernet7/1/8]traffic-shape queue 2 500 12
```

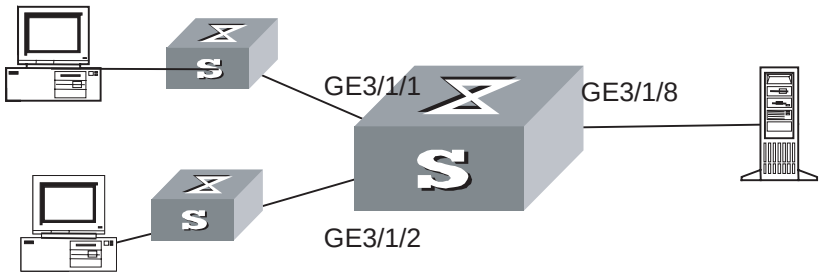
Port Mirroring Configuration Example

Use one server to monitor the packets of two ports. R&D department is accessed from the port GE3/1/1 and sales department from the port GE3/1/2. The server is connected to the port GE3/1/8.

The mirroring port and the mirrored ports must be on the same interface unit.

On one interface unit, only one mirroring group can be configured in one direction. For example, you can only configure one mirroring group for the inbound packets on one interface unit. Failure will be prompted if you configure a second. The same restriction applies to outbound packets.

Figure 10 Networking for a QoS configuration



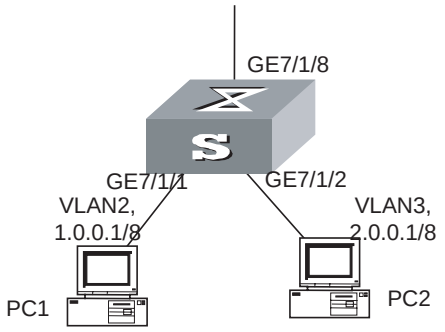
Define a mirroring group, with the monitoring port as GigabitEthernet3/1/8.

```
[SW8800]mirroring-group 1 inbound GigabitEthernet3/1/1
GigabitEthernet3/1/2 mirrored-to GigabitEthernet3/1/8
[SW8800]mirroring-group 2 outbound GigabitEthernet3/1/1
GigabitEthernet3/1/2 mirrored-to GigabitEthernet3/1/8
```

Traffic Priority Configuration Example

Re-allocate service parameters according to the mapping table for DSCP 63 for the packets from PC1 (IP 1.0.0.1) during the time range 8:00 to 18:00 everyday.

Figure 11 Networking for a QoS configuration



1 Define the time range from 8:00 to 18:00.

```
[SW8800]time-range 3com 8:00 to 18:00 daily
```

2 Define the traffic from PC1.

Create a number-based basic ACL 2000 and enter it.

```
[SW8800]acl number 2000
```

Define ACL rule for the traffic from PC1.

```
[SW8800-acl-basic-2000]rule 0 permit source 1.0.0.1 0 time-range
3com
```

3 Define the CoS-> Conform-Level mapping table. The switch allocates drop precedence (all as 0 for the sake of simplification) for them when receiving packets.

```
[SW8800]qos cos-drop-precedence-map 0 0 0 0 0 0 0 0
```

The modified CoS-> Conform-Level mapping table:

Table 26 Modified CoS-> Conform-Level Mapping Table

COS Value	Drop-precedence
0	0
1	0
2	0
3	0
4	0
5	0

Table 26 Modified CoS-> Conform-Level Mapping Table

COS Value	Drop-precedence
6	0
7	0

4 Define the DSCP + Conform-Level -> Service parameter mapping table. Allocate a set of service parameters for the packets from PC1 according the mapping table for DSCP 63.

```
[SW8800]qos conform-level 0
[SW8800-conform-level-0]dscp 63 : 32 4 4 4 0
```

The modified DSCP + Conform-Level -> Service parameter mapping table: Re-allocate service parameters for the packets from PC1.

Table 27 Modified DSCP+Conform-Level>Service Parameter Mapping Table

DSCP	CL	Policied-DSCP	Policied-EXP	Policied-802.1p	Policied-Localprec	Policied-Drop Precedence
63	0	32	4	4	4	0

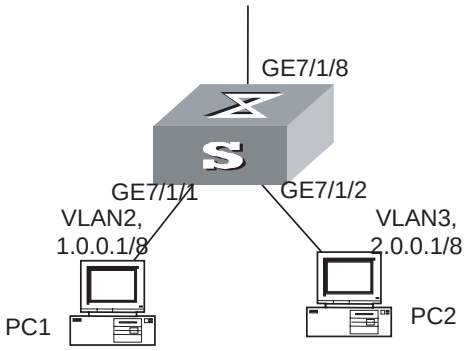
Re-allocate service parameters for the packets from PC1.

```
[SW8800-GigabitEthernet7/1/1]traffic-priority inbound ip-group 2000
dscp 63
```

Traffic Redirection Configuration Example

Forward the packets sent from PC1 (IP 1.0.0.1) during the time range from 8:00 to 18:00 every day to the address 2.0.0.1.

Figure 12 Networking for QoS configuration



1 Define the time range from 8:00 to 18:00.

```
[SW8800]time-range 3com3com 8:00 to 18:00 daily
```

2 Define the traffic from PC1.

Create a number-based basic ACL 2000 and enter it.

```
[SW8800]acl number 2000
```

Define ACL rule for the traffic from PC1.

```
[SW8800-acl-basic-2000]rule 0 permit source 1.0.0.1 0 time-range
3com
```

3 Modify the next hop for the packets from PC1.

Define the next hop for the packets from PC1 as 2.0.0.1.

```
[SW8800-GigabitEthernet7/1/1]traffic-redirect inbound ip-group 2000
rule 0 next-hop 2.0.0.1
```

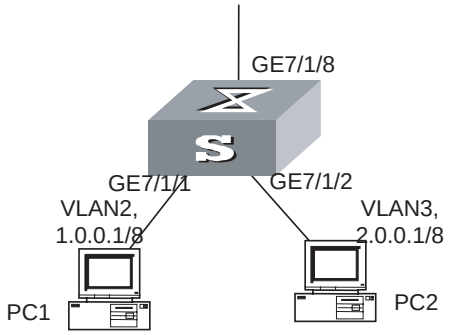
Queue Scheduling Configuration Example

Modify the correspondence between 802.1p priority levels and local priority levels to change the mapping between 802.1p priority levels and queues so that packets are put into outbound queues according to the new mapping. Use WRR algorithm for the queues 0 to 5 at the port GE7/1/1. Set the queues 0, 1 and 2 into WRR queue 1, with weight respectively as 20, 20 and 30; set the queues 3, 4 and 5 into WRR queue 2, with weight respectively as 20, 20 and 40. The queues 6 and 7 use the SP algorithm. See Queue Scheduling for the default mapping.

Table 28 802.1p Priority -> Local Precedence Mapping Table

802.1p priority	Local precedence
0	7
1	6
2	5
3	4
4	3
5	2
6	1
7	0

Figure 13 Networking for QoS configuration



1 Re-specify the mapping between 802.1p priority and local precedence.

```
[SW8800]qos cos-local-precedence-map 7 6 5 4 3 2 1 0
```

2 Use the WRR algorithm for the queues 0 to 5. Set the queues 0, 1 and 2 into WRR queue 1, with weight respectively as 20, 20 and 30; set the queues 3, 4 and 5 into WRR queue 2, with weight respectively as 20, 20 and 40. Use SP algorithm for the queues 6 and 7.

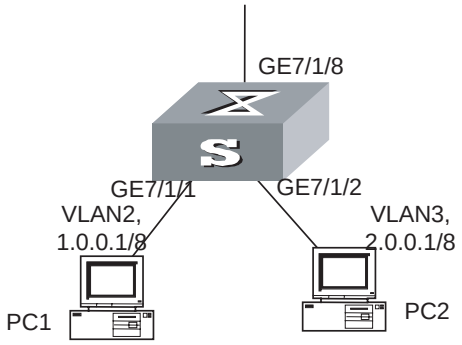
```
[SW8800-GigabitEthernet7/1/1]queue-scheduler wrr group1 0 20 1 20 2
30 group2 3 20 4 20 5 40
[SW8800]display qos-interface GigabitEthernet7/1/1 queue-scheduler
```

```
Ethernet7/1/1 Port scheduling:

 QID:   scheduling-group     weight

-----------------------------------

  0 :   wrr , group1           20

  1 :   wrr , group1           20

  2 :   wrr , group1           30

  3 :   wrr , group2           20

  4 :   wrr , group2           20

  5 :   wrr , group2           40

  6 :   sp                      0

  7 :   sp                      0
```

WRED Parameters Configuration Example

Set WRED parameters and drop algorithm for packets at the port GE7/1/1: Configure parameters for WRED 0; outbound queue ID is 7; green-min-threshold is 150; green-max-threshold is 500; green-max-prob is 5; yellow-min-threshold is 100; yellow-max-threshold is 150; yellow-max-prob is 10; red-min-threshold is 50; red-max-threshold is 100; red-max-prob is 15; exponent is 10; the port is in WRED drop mode; import the parameters of WRED 0.

Figure 14 Networking for QoS configuration



1 Configure parameters for WRED 0.

```
[SW8800]wred 0
[SW8800-wred-0]queue 7 150 500 5 100 150 10 50 100 15 10
```

2 Set drop algorithm and thresholds.

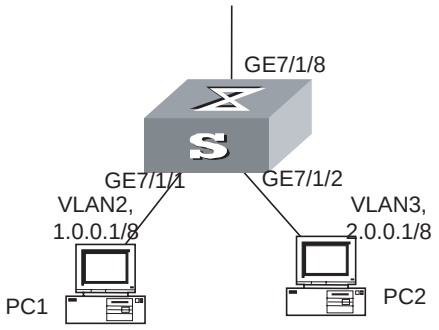
Define the port GE7/1/1 in WRED drop mode, set the parameters of WRED 0.

```
[SW8800-GigabitEthernet7/1/1]drop-mode wred 0
```

Traffic Statistics Configuration Example

Suppose the IP address of PC1 is 1.0.0.1 and that of PC2 is 2.0.0.1. The switch is uplinked through the port GE7/1/8. Count the packets sent from the switch to PC1 during the time range from 8:00 to 18:00 every day.

Figure 15 Networking for QoS Configuration



1 Define the time range from 8:00 to 18:00.

```
[SW8800]time-range 3com 8:00 to 18:00 daily
```

2 Define the traffic from PC1.

Define ACL rule for the traffic from PC1.

```
[SW8800]acl number 2000
[SW8800-acl-basic-2000]rule 0 permit source 1.0.0.1 0.0.0.0
time-range 3com
```

3 Count the packets to PC1 and display the result using the display command.

```
[SW8800-GigabitEthernet7/1/1]traffic-statistic inbound ip-group 2000
rule 0
[SW8800]display qos-interface GigabitEthernet7/1/1 traffic-statistic
```

Configuring Logon User ACL Control

As switches are used more and more widely over the networks, the issue of security becomes even more important. The switches provide several logon and device accessing measures, mainly including TELNET access, SNMP access, and HTTP access. The security control over the access measures is provided with the switches to prevent illegal users from logging on to and accessing the devices. There are two levels of security controls. At the first level, the user connection is controlled with ACL filter and only the legal users can be connected to the switch. At the second level, a connected user can log on to the device only if he can pass the password authentication.

This chapter mainly introduces how to configure the first level security control over these access measures, that is, how to configure to filter the logon users with ACL. For detailed description about how to configure the first level security, refer to "getting started" module of Operation Manual.

Configuring ACL for Telnet Users

This configuration can filter out malicious or illegal connection requests before password authentication.

Two steps are included in this configuration:

1 Define an ACL

2 Import the ACL to control Telnet users

Defining ACLs

Currently only number-based ACLs can be imported, with the number ranging from 2000 to 3999.

Perform the following configurations in system view.

Table 29 Defining Basic ACLs

Operation	Command
Enter basic ACL (system view)	**acl { number** acl-number | **name** acl-name **basic** } **match-order { config | auto }**
Define a sub-rule (basic ACL view)	**rule** [rule-id] { **permit | deny** } [**source** source-addr wildcard | **any] [fragment] [time-range name**]
Delete a sub-rule (basic ACL view)	**undo rule** rule-id [**source] [fragment] [time-range**]
Delete an ACL or all ACLs (system view)	**undo acl { number** acl-number | **name** acl-name | all }

You can define multiple rules for an ACL by using the rule command several times.

Importing ACL

You can import a defined ACL in user interface view to achieve ACL control.

Perform the following configurations in system view and user interface view.

Table 30 Importing ACL

Operation	Command
Enter user interface view (system view)	**user-interface** [type] first-number [last-number]
Import the ACL (user interface view)	**acl** acl-number { **inbound | outbound** }

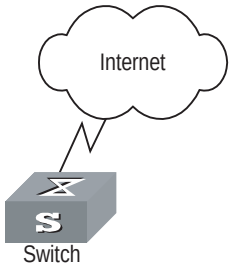
See the *Switch 8800 Command Reference Guide* for details about these commands.

Currently you can import only the basic ACLs with digit IDs.

Configuration Example

Only the Telnet users from 10.110.100.52 and 10.110.100.46 can access the switch.

Figure 16 ACL Configuration for Telnet Users



1 Define a basic ACL.

```
[SW8800]acl number 2000 match-order config
[SW8800-acl-basic-2000]rule 1 permit source 10.110.100.52 0
```

```
[SW8800-acl-basic-2000]rule 2 permit source 10.110.100.46 0
[SW8800-acl-basic-2000]quit
```

2 Import the ACL.

```
[SW8800]user-interface vty 0 4
[SW8800-user-interface-vty0-4]acl 2000 inbound
```

Configuring ACL for SNMP Users

3Com switches support remote network management (NM) and the user can use SNMP to access them. Proper ACL configuration can prevent illegal users from logging onto the switches.

Two steps are included in this configuration:

1 Define an ACL

2 Import the ACL to control SNMP users

Defining an ACL

Currently only number-based ACLs can be imported, with the number ranging from 2000 to 2999. See 3.3.1 Defining ACL for detailed configuration.

Importing the ACL

Import the defined ACL into the commands with SNMP community, username and group name configured, to achieve ACL control over SNMP users.

Perform the following configurations in system view.

Table 31 Importing an ACL

Operation	Command
Import the defined ACL into the commands with SNMP community configured	**snmp-agent community { read | write }** community-name [[**mib-view** view-name] | [acl **acl**-number]]*
Import the defined ACL into the commands with SNMP group name configured	■ **snmp-agent group { v1 | v2c }** group-name [**read-view** read-view] [**write-view** write-view] [**notify-view** notify-view] [**acl** acl-number] ■ **snmp-agent group v3** group-name [**authentication | privacy**] [**read-view** read-view] [**write-view** write-view] [**notify-view** notify-view] [**acl** acl-number]
Import the defined ACL into the commands with SNMP username configured	■ **snmp-agent usm-user** { **v1 | v2c** } user-name group-name [acl acl-number] ■ s**nmp-agent usm-user v3** user-name group-name [**authentication-mode { md5 | sha }** auth-password] [**privacy-mode des56** priv-password] [acl acl-number]

SNMP community is one of the features of SNMP v1 and SNMP v2, so you import the ACL into the commands with SNMP community configured, for the SNMP V1 and SNMP V2.

SNMP username or group name is one of the features of SNMP V2 and above, therefore you import the ACL into the commands with SNMP username or group name configured, for the SNMP V2 and above. If you import the ACL into both features, the switch will filter both features for the users.

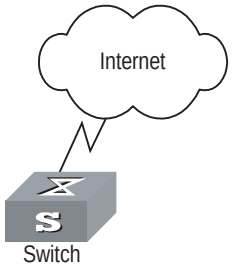
You can import different ACLs in the three commands listed above.

See the *Switch 8800 Command Reference Guide* for details about these commands.

Currently you can import only the basic ACLs with digit IDs.

Configuration Example Only SNMP users from 10.110.100.52 and 10.110.100.46 can access the switch.

Figure 17 ACL configuration for SNMP users



1 Define a basic ACL.

```
[SW8800]acl number 2000 match-order config
[SW8800-acl-baisc-2000]rule 1 permit source 10.110.100.52 0
[SW8800-acl-baisc-2000]rule 2 permit source 10.110.100.46 0
[SW8800-acl-baisc-2000]quit
```

2 Import the ACL.

```
[SW8800]snmp-agent community read 3com acl 2000
[SW8800]snmp-agent group v2c 3comgroup acl 2000
[SW8800]snmp-agent usm-user v2c 3comuser 3comgroup acl 2000
```

8 STP OPERATION

This chapter covers the following topics:

- STP Overview
- Configuring STP
- MSTP Overview
- Configuring MSTP

STP Overview

Spanning Tree Protocol (STP), defined by IEEE 802.1D, is applied in a loop network to block undesirable redundant paths. Using STP avoids the proliferation and infinite cycling of a packet in a loop network.

The fundamental feature of STP is that the switches exchange packets called configuration Bridge Protocol Data Units, or BPDU, to decide the topology of the network. The configuration BPDU contains the information that ensures that switches can compute the spanning tree.

The configuration BPDU contains the following information:

- The root ID consisting of root priority and MAC address
- The cost of the shortest path to the root
- A designated switch ID consisting of designated switch priority and MAC address
- A designated port ID consisting of port priority and port number
- The age of the configuration BPDU (MessageAge)
- The maximum age of the configuration BPDU (MaxAge)
- A configuration BPDU interval (HelloTime)
- A forward delay of the port (ForwardDelay)

Configuring STP

STP configuration is described in the following sections:

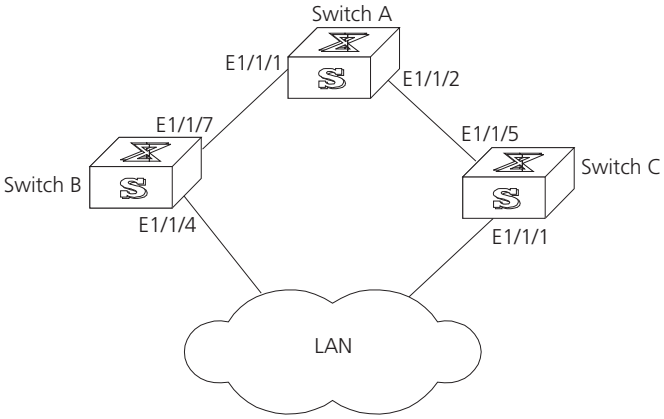
- Designating Switches and Ports
- Calculating the STP Algorithm
- Generating the Configuration BPDU
- Selecting the Optimum Configuration BPDU
- Designating the Root Port
- Configuring the BPDU Forwarding Mechanism

Designating Switches and Ports

A designated switch is a switch in charge of forwarding packets to the local switch by a port called the designated port. For a LAN, the designated switch is a switch that forwards packets to the network segment by the designated port.

As illustrated in Figure 1, Switch A forwards data to Switch B through GigabitEthernet port1/1/1. So to Switch B, the designated switch is Switch A and the designated port is GigabitEthernet1/1/1 of Switch A. Also, Switch B and Switch C are connected to the LAN and Switch B forwards packets to the LAN. So the designated switch of LAN is Switch B and the designated port is GigabitEthernet1/1/4 of Switch B.

Figure 1 Designated Switch and Designated Port

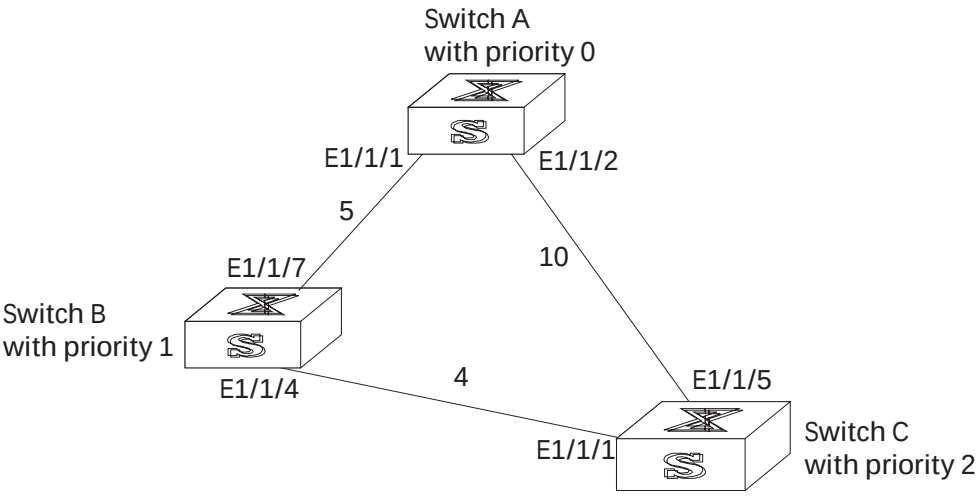


Calculating the STP Algorithm

The following example illustrates the calculation process of STP.

The figure1-2 below illustrates the network.

Figure 2 Switch 8800 Networking



To facilitate the descriptions, only the first four parts of the configuration BPDU are given in the example. They are root ID (expressed as Ethernet switch priority), path cost to the root, designated switch ID (expressed as Ethernet switch priority) and the designated port ID (expressed as the port number). As illustrated in the figure above, the priorities of Switch A, B and C are 0, 1, and 2 and the path costs of their links are 5, 10, and 4.

Generating the Configuration BPDU

When initialized, each port of the switches will generate the configuration BPDU taking itself as the root, root path cost as 0, designated switch IDs as their own switch IDs, and the designated ports as their ports.

- Switch A

  Configuration BPDU of GigabitEthernet1/1/1: {0, 0, 0, e1/1/1}

  Configuration BPDU of GigabitEthernet1/1/2: {0, 0, 0, e1/1/2}

- Switch B

  Configuration BPDU of GigabitEthernet1/1/7: {1, 0, 1, e1/1/7}

  Configuration BPDU of GigabitEthernet1/1/4: {1, 0, 1, e1/1/4}

- Switch C

  Configuration BPDU of GigabitEthernet1/1/1: {2, 0, 2, e1/1/1}

  Configuration BPDU of GigabitEthernet1/1/5: {2, 0, 2, e1/1/5}

Selecting the Optimum Configuration BPDU

Every switch transmits its configuration BPDU to others. When a port receives a configuration BPDU with a lower priority than that of its own, it will discard the message and keep the local BPDU unchanged. When a higher-priority configuration BPDU is received, the local configuration BPDU will be updated.

The optimum configuration BPDU will be elected through comparing the configuration BPDUs of all the ports.

The comparison rules are:

- The configuration BPDU with a smaller root ID has a higher priority
- If the root IDs are the same, perform the comparison based on root path costs. The cost comparison is as follows: the path cost to the root recorded in the configuration BPDU plus the corresponding path cost of the local port is set as X, the configuration BPDU with a smaller X has a higher priority.
- If the costs of a path to the root are the same, compare, in sequence, the designated switch ID, designated port ID, and the ID of the port through which the configuration BPDU was received.

Designating the Root Port

On a bridge, the port receiving the optimum configuration BPDU is considered the root port whose configuration BPDU remains the same. Any other port, whose configuration BPDU has been updated, as explained in "Selecting the Optimum Configuration BPDU", will be blocked and will not forward any data. In addition, any other port only receives, but does not retransmit, a BPDU and its BPDU remains the same.

On other bridges, a port whose BPDU has not been updated is called the designated port. Its configuration BPDU is modified by substituting:

- The root ID with the root ID in the configuration BPDU of the root port
- The cost of path to root with the value made by the root path cost, plus the path cost corresponding to the root port
- The designated switch ID with the local switch ID
- The designated port ID with the local port ID

The comparison process of each switch is:

- Switch A

  GigabitEthernet1/1/1 receives the configuration BPDU from Switch B and finds out that the local configuration BPDU priority is higher than that of the received one, so it discards the received configuration BPDU.

  The configuration BPDU is processed on the GigabitEthernet1/1/2 in a similar way. Thus, Switch A finds itself the root and designated switch in the configuration BPDU of every port; it regards itself as the root, retains the configuration BPDU of each port and transmits configuration BPDU to others regularly thereafter. By now, the configuration BPDUs of the two ports are as follows:

  Configuration BPDU of GigabitEthernet1/1/1: {0, 0, 0, e1/1/1}

  Configuration BPDU of GigabitEthernet1/1/2: {0, 0, 0, e1/1/2}

- Switch B

  GigabitEthernet1/1/7 receives the configuration BPDU from Switch A and finds that the received BPDU has a higher priority than the local one, so it updates its configuration BPDU.

  GigabitEthernet1/1/4 receives the configuration BPDU from Switch C and finds that the local BPDU priority is higher than that of the received one, so it discards the received BPDU.

  By now the configuration BPDUs of each port are as follows:

  Configuration BPDU of GigabitEthernet1/1/7: {0, 0, 0, e1/1/1}

  Configuration BPDU of GigabitEthernet1/1/4: {1, 0, 1, e1/1/4}

  Switch B compares the configuration BPDUs of the ports and selects the GigabitEthernet1/1/7 BPDU as the optimum one. Thus, GigabitEthernet1/1/7 is elected as the root port and the configuration BPDUs of Switch B ports are updated as follows.

  The configuration BPDU of the root port GigabitEthernet1/1/7 remains {0, 0, 0, e1/1/1}. GigabitEthernet1/1/4 updates the root ID with the root ID in the optimum configuration BPDU, updates the path cost to root with 5, sets the designated switch as the local switch ID and the designated port ID as the local port ID. Thus, the configuration BPDU becomes {0, 5, 1, e1/1/4}.

  All the designated ports of Switch B then transmit the configuration BPDUs regularly.

- Switch C

  GigabitEthernet1/1/1 receives from the GigabitEthernet1/1/4 of Switch B, the configuration BPDU {1, 0, 1, e1/1/4} that has not been updated, then the updating process is launched. {1, 0, 1, e1/1/4}.

  GigabitEthernet1/1/5 receives the configuration BPDU {0, 0, 0, e1/1/2} from Switch A, and Switch C launches the updating. The configuration BPDU is updated as {0, 0, 0, e1/1/2}.

  By comparison, the GigabitEthernet1/1/5 configuration BPDU is elected as the optimum one. The GigabitEthernet1/1/5 is thus specified as the root port with no modifications made on its configuration BPDU. However, GigabitEthernet1/1/1 is blocked and its BPDU also remains the same, but it will not receive the data (excluding the STP packet) forwarded from Switch B until

spanning tree calculation is launched again by new events, for example, the link from Switch B to C is down or the port receives a better configuration BPDU.

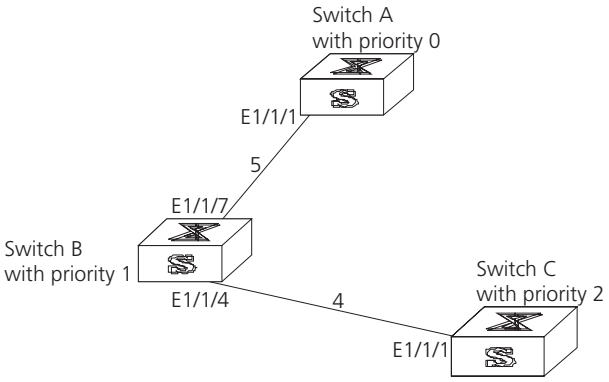
GigabitEthernet1/1/1 receives the updated configuration BPDU, {0, 5, 1, e1/1/4}, from Switch B. Since this configuration BPDU is better then the old one, the old BPDU will be updated to {0, 5, 1, e1/1/4}.

Meanwhile, GigabitEthernet1/1/5 receives the configuration BPDU from Switch A but its configuration BPDU is not updated and remains {0, 0, 0, e1/1/2}.

By comparison, the configuration BPDU of GigabitEthernet1/1/1 is elected as the optimum one. GigabitEthernet1/1/1 is elected as the root port, whose BPDU does not change, while GigabitEthernet1/1/5 is blocked and retains its BPDU, but it does not receive the data forwarded from Switch A until spanning tree calculation is triggered again by changes, for example, the link from Switch B to C is down.

Thus the spanning tree is stabilized. The tree with the root Switch A is illustrated in Figure 3.

Figure 3 The Final Stabilized Spanning Tree



The root ID and the designated switch ID, in actual calculation, should include both switch priority and switch MAC address. The designated port ID should include port priority and port MAC address. In the updating process of a configuration BPDU, other configuration BPDUs besides the first four items make modifications according to certain rules. The basic calculation process is described below.

Configuring the BPDU Forwarding Mechanism

Upon the initiation of the network, all the switches regard themselves as the roots. The designated ports send the configuration BPDUs of local ports at a regular interval of HelloTime. If it is the root port that receives the configuration BPDU, the switch will enable a timer to time the configuration BPDU, as well as increase MessageAge carried in the configuration BPDU by certain rules. If a path goes wrong, the root port on this path will not receive configuration BPDUs anymore, and the old configuration BPDUs will be discarded due to timeout. Recalculation of the spanning tree will be initiated to generate a new path to replace the failed one, and thus restore the network connectivity.

The new configuration BPDU as now recalculated will not be propagated throughout the network right away, so the old root ports and designated ports, that have not detected the topology change, will continue to forward the data

through the old path. If the new root port and designated port begin to forward data immediately after they are elected, a occasional loop may still occur. In RSTP, a transitional state mechanism is then adopted to ensure the new configuration BPDU has been propagated throughout the network before the root port and designated port begin to send data again. That is, the root port and designated port should undergo a transitional state for a period of Forward Delay before they enter the forwarding state.

MSTP Overview

The Switch 8800 implements the Multiple Spanning Tree Protocol (MSTP), defined by IEEE 802.1s. MSTP is an enhancement to STP, and is compatible with both STP and RSTP, defined in IEEE 802.1w. An MSTP switch can recognize both STP and RSTP packets and can calculate the spanning tree with them. Beside the basic MSTP functions, the Switch 8800 provides additional MSTP features which include root bridge hold, secondary root bridge, root protection, and BPDU protection.

STP cannot stabilize a network rapidly. Even on the point-to-point link or the edge port, it takes an interval as long as twice the forward delay before the network converges.

MSTP makes the network converge rapidly, and distributes the traffic of different VLANs along their respective paths. This provides a better load-balance mechanism for the redundant links.

MSTP associates VLAN with a spanning tree domain, and divides a switching network into several regions, each of which has a spanning tree independent of one another. MSTP prunes the network into a loopfree tree to avoid proliferation, it also provides multiple redundant paths for data forwarding to implement the VLAN data forwarding load-balance.

Configuring MSTP is described in the following sections:

- MSTP Concepts
- MSTP Principles

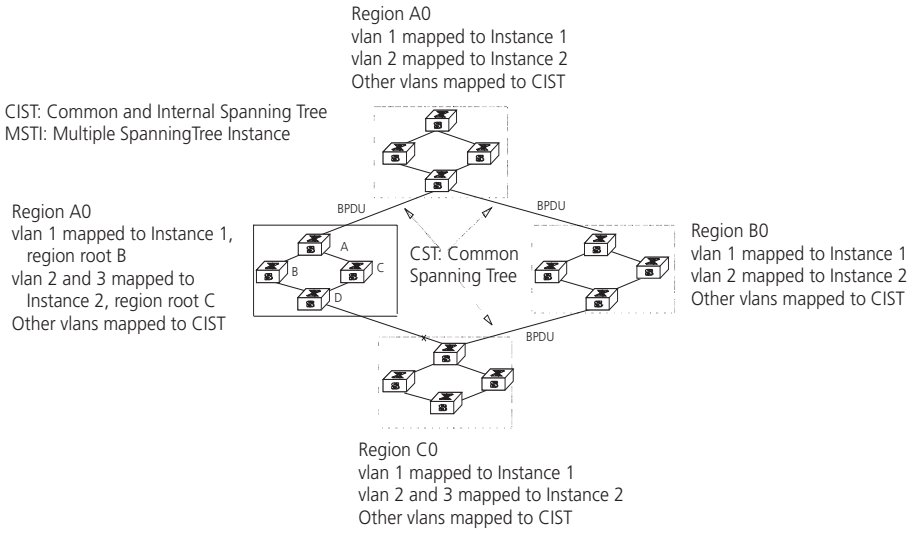
MSTP Concepts

MSTP Concepts are described in the following sections

- MST Region
- VLAN Mapping Table
- Internal Spanning Tree (IST)
- Common Spanning Tree (CST)
- Common and Internal Spanning Tree (CIST)
- Multiple Spanning Tree Instance (MSTI)
- MSTI Region root
- Common Root Bridge
- Boundary port
- Port role

There are 4 MST regions in Figure 4.

Figure 4 MSTP Concepts



MST Region

A multiple spanning tree region contains several physically and directly connected MSTP-capable switches sharing the same region name, VLAN-spanning tree mapping configuration and MSTP revision level configuration, and the network segments between them. There can be several MST regions on a switching network. You can group several switches into a MST region, using MSTP configuration commands. For example, in Figure 4, in MST region A0, the 4 switches are configured with the same region name, vlan mapping table (VLAN1 map to instance 1, VLAN 2 map to instance 2, other VLAN map to instance 0), and revision level (not indicated in Figure 4).

VLAN Mapping Table

A VLAN mapping table is an attribute of an MST region and is used for describing the mapping relationship of VLAN and STI. For example, the VLAN mapping table of MST region A0 in Figure 4 is VLAN1 map to instance 1, VLAN 2 map to instance 2, other VLAN map to instance 0.

Internal Spanning Tree (IST)

The entire switching network has a Common and Internal Spanning Tree (CIST). An MSTP region has an Internal Spanning Tree (IST), which is a fragment of CIST. For example, every MST region in Figure 4 has an IST.

Common Spanning Tree (CST)

CST connects the spanning trees of the MST region. Taking every MST region as a "switch", the CST can be regarded as their spanning tree generated with STP/RSTP. For example, the red line indicates the CST in Figure 4.

Common and Internal Spanning Tree (CIST)

A single spanning tree made of IST and CST. The CIST in Figure 4 is composed of each IST in every MST region and the CST.

Multiple Spanning Tree Instance (MSTI)

Multiple spanning trees can be generated in an MST region and are independent of one another. Each of these spanning trees is called an MSTI.

MSTI Region root

The MSTI region root refers to the root of the MSTI in an MST region. Each spanning tree in an MST region can have a different topology with a different region root.

Common Root Bridge

The common root bridge refers to the root bridge of the CIST. There is only one common root bridge in the network.

Boundary port

The boundary port refers to the port located at the edge of the MST region. The boundary port connects different MST regions, an MST region and an STP region, or an MST region and an RSTP region. For MSTP calculation, the boundary port has the same role on MSTI and CIST instance. For example, the boundary port as a master port on a CIST instance should serve as a master port on every MSTI in the region.

Port role

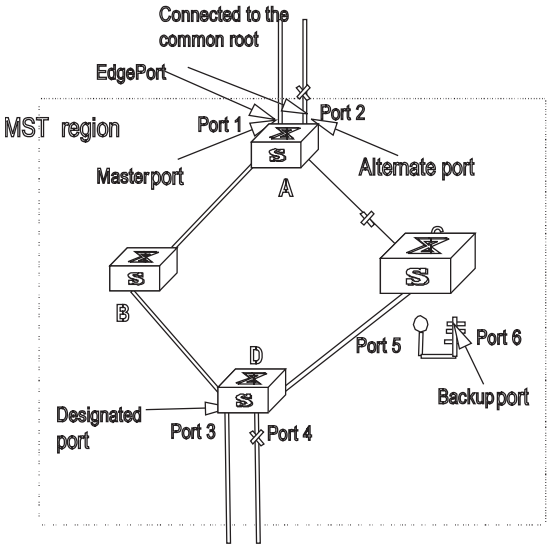
In the process of MSTP calculation, a port can serve as a designated port, root port, master port, alternate port, or BACKUP.

- The root port is the port through which the data is forwarded to the root.
- The designated port is the one through which the data is forwarded to the downstream network segment or switch.
- Master port is the port connecting the entire region to the common root bridge and located on the shortest path between them.
- An alternate port is the backup of the master port. When the master port is blocked, the alternate port takes its place.
- If two ports of a switch are connected, there must be a loop. In this case, the switch will block one of them. The blocked port is called BACKUP port.

A port can play different roles in different spanning tree instances.

Figure 5 illustrates the these concepts.

Figure 5 Port Roles



MSTP Principles

MSTP divides the entire Layer 2 network into several MST regions, and calculates and generates CST for them. Multiple spanning trees are generated in a region and each of them is called an MSTI. The instance 0 is called IST, and others are called MSTI.

CIST calculation

The CIST root is the highest-priority switch, elected from the switches on the entire network by comparing their configuration BPDUs. MSTP calculates and generates an IST in an MST region and also the CST connecting the regions. CIST is the unique single spanning tree of the entire switching network.

MSTI calculation

Inside an MST region, MSTP generates different MSTIs for different VLANs according to the association between the VLAN and the spanning tree.

In this way, the packets of a VLAN travel along the corresponding MSTI; inside the MST region and the CST between different regions.

Configuring MSTP

Configuring MSTP includes tasks that are described in the following sections:

- Configuring the MST Region for a Switch
- Specifying the Switch as Primary or Secondary Root Switch
- Configuring the MSTP Operating Mode
- Configuring the Bridge Priority for a Switch
- Configuring the Max Hops in an MST Region
- Configuring the Switching Network Diameter
- Configuring the Time Parameters of a Switch
- Configuring the Max Transmission Speed on a Port
- Configuring a Port as an Edge Port

- Configuring the Path Cost of a Port
- Configuring the Priority of a Port
- Configuring the Port Connection with the Point-to-Point Link
- Configuring the mCheck Variable of a Port
- Configuring the Switch Security Function
- Enabling MSTP on the Device
- Enabling or Disabling MSTP on a Port
- Displaying and Debugging MSTP

Only after MSTP is enabled on the device will other configurations take effect. Before enabling MSTP, you can configure the related parameters of the device and Ethernet ports. The configuration of the related parameters and Ethernet ports will take effect upon enabling MSTP, and stay effective even after resetting MSTP.

The **display stp-region-configuration** command shows the parameters that are configured before MSTP is enabled. To display parameters configured after MSTP is enabled, you can use the related **display** commands. For detailed information, see "Displaying and Debugging MSTP".

You do not have to perform all these tasks to configure MSTP. Many of them are designed to adjust the MSTP parameters provided with default values. You can configure these parameters depending on your actual conditions or simply take the defaults. For more detailed information, refer to the task description or to the command descriptions in the *Switch 8800 Command Reference Guide*.

When GVRP and MSTP start up on the switch simultaneously, GVRP packets will propagate along CIST, which is a spanning tree instance. In this case, if you want to issue a certain VLAN through GVRP on the network, you should make sure that the VLAN is mapped to CIST when configuring the VLAN mapping table of MSTP. CIST is spanning tree instance 0.

Configuring the MST Region for a Switch

The MST region that a switch belongs to is determined with the configurations of the region name, VLAN mapping table, and MSTP revision level. You can perform the following configurations to put a switch into an MST region.

Tasks for configuring the MST Region for a Switch is described in the following sections:

- Entering MST region view
- Configuring the MST Region
- Activating the MST Region Configuration and Exiting the MST Region View

Entering MST region view

Perform the following configuration in system view.

Table 1 Enter MST Region View

Operation	Command
Enter MST region view (from system view)	stp region-configuration
Restore the default settings of MST region	undo stp region-configuration

Configuring the MST Region

Perform the following configuration in MST region view.

Table 2 Configure the MST Region for a Switch

Operation	Command
Configure MST region name	**region-name** *name*
Restore the default MST region name	**undo region-name**
Configure VLAN mapping table	**instance** *instance-id* **vlan** *vlan-list*
Restore the default VLAN mapping table	**undo instance**
Configure the MSTP revision level of MST region	**revision-level** *level*
Restore the MSTP revision level of MST region	**undo revision-level**

An MST region can contain up to 16 spanning tree instances, among which Instance 0 is an IST and instances 1 through 16 are MSTIs. Upon the completion of these configurations, the current switch is put into a specified MST region.

Two switches belong to the same MST region only if they have been configured with the same MST region name, STI-VLAN mapping tables of an MST region, and the MST region revision level.

Configuring the related parameters, especially the VLAN mapping table, of the MST region will lead to the recalculation of spanning tree and network topology flapping. To reduce such flapping, MSTP triggers to recalculate the spanning tree according to the configurations only if one of the following conditions are met:

- The user manually activates the configured parameters related to the MST region, using the **active region-configuration** command.
- The user enables MSTP, using the **stp enable** command.

By default, the MST region name is the first switch MAC address, all the VLANs in the MST region are mapped to the STI 0, and the MSTP region revision level is 0. You can restore the default settings of MST region, using the **undo stp region-configuration** command in system view.

Activating the MST Region Configuration and Exiting the MST Region View

Perform the following configuration in MST region view.

Table 3 Activate the MST Region Configuration and Exit the MST Region View

Operation	Command
Show the configuration information of the MST region under revision (from MST region view)	**check region-configuration**
Manually activate the MST region configuration (from MST region view)	**active region-configuration**
Exit MST region view (from MST region view)	**quit**

Specifying the Switch as Primary or Secondary Root Switch

MSTP can determine the spanning tree root through calculation. You can also specify the current switch as the root, using the command provided by the switch.

You can use the following commands to specify the current switch as the primary or secondary root of the spanning tree.

Perform the following configuration in system view.

Table 4 Specify the Switch as Primary or Secondary Root Switch

Operation	Command
Specify current switch as the primary root switch of the specified spanning tree.	**stp instance** *instance-id* **root primary** [**bridge-diameter** *bridgenum* [**hello-time** *centi-senconds*]]
Specify current switch as the secondary root switch of the specified spanning tree.	**stp instance** *instance-id* **root secondary** [**bridge-diameter** *bridgenum* [**hello-time** *centi-senconds*]]
Specify current switch not to be the primary or secondary root.	**undo stp instance** *instance-id* **root**

After a switch is configured as primary root switch or secondary root switch, you cannot modify the bridge priority of the switch.

You can configure the current switch as the primary or secondary root switch of the STI (specified by the **instance** *instance-id* parameter). If the *instance-id* takes 0, the current switch is specified as the primary or secondary root switch of the CIST.

The root types of a switch in different STIs are independent of one another. A switch can be a primary or secondary root of any STI. However, a switch cannot serve as both the primary and secondary roots of one STI.

If the primary root is down or powered off, unless you configure a new primary root, the secondary root will take its place. If there are two or more configured secondary root switches, MSTP selects the one with the smallest MAC address to take the place of the failed primary root.

When configuring the primary and secondary switches, you can also configure the network diameter and hello time of the specified switching network. For detailed information, refer to the configuration tasks "Configuring the Switching Network Diameter" and "Configuring the Time Parameters of a Switch".

You can configure the current switch as the root of several STIs, however, it is not necessary to specify two or more roots for an STI. In other words, please do not specify the root for an STI on two or more switches.

You can configure more than one secondary root for a spanning tree by specifying the secondary STI root on two or more switches.

Generally, you are recommended to designate one primary root and more than one secondary root for a spanning tree.

By default, a switch is neither the primary root or the secondary root of the spanning tree.

Configuring the MSTP Operating Mode

MSTP and RSTP are compatible and can recognize each other's packets. However, STP cannot recognize MSTP packets. To implement the compatibility, MSTP provides two operation modes, STP-compatible mode and MSTP mode. In STP-compatible mode, the switch sends STP packets by every port and serves as a

region itself. In MSTP mode, the switch ports send MSTP or STP packets (when connected to the STP switch) and the switch provides the multiple spanning tree function.

You can use the following command to configure the MSTP operational mode. MSTP can intercommunicate with STP. If there is a STP switch in the switching network, you can use the command to configure the current MSTP to run in STP-compatible mode, otherwise, configure it to run in MSTP mode.

Perform the following configuration in system view.

Table 5 Configure the MSTP Operating Mode

Operation	Command
Configure MSTP to run in STP-compatible mode	**stp mode stp**
Configure MSTP to run in MSTP mode.	**stp mode mstp**
Restore the default MSTP operating mode	**undo stp mode**

Generally, if there is a STP switch on the switching network, the port connected to it will automatically transit from MSTP mode to STP-compatible mode. The port cannot automatically transition itself back to MSTP mode after the STP switch is removed. In this case, you can perform the mcheck operation to transit the port to MSTP mode by force.

By default, MSTP runs in MSTP mode.

Configuring the Bridge Priority for a Switch

Whether or not a switch can be elected as the spanning tree root, depends on its bridge priority. The switch configured with a lower bridge priority is more likely to become the root. An MSTP switch can have different priorities in different STIs.

You can use the following command to configure the bridge priorities of the designated switch in different STIs.

Perform the following configuration in system view.

Table 6 Configure the Priority for a Switch

Operation	Command
Configure the priority of the designated switch.	**stp instance** *instance-id* **priority** *priority*
Restore the default priority of the designated switch.	**undo stp instance** *instance-id* **priority**

When configuring the switch priority with the **instance** *instance-id* parameter, with a value of 0, you are configuring the CIST priority of the switch.

In the process of spanning tree root election of two or more switches, with the lowest priorities, the one has a smaller MAC address will be elected as the root.

By default, the switch priority is 32768.

Configuring the Max Hops in an MST Region

The scale of an MST region is limited by the max hops in the MST region; which is configured on the region root. As the BPDU travels from the spanning tree root,

each time it is forwarded by a switch, the max hop is reduced by 1. The switch discards the configuration BPDU with 0 hops left. This makes it impossible for the switch beyond the max hops to take part in the spanning tree calculation, thereby limiting the scale of the MST region.

You can use the following command to configure the max hops in an MST region.

Perform the following configuration in system view.

Table 7 Configure the Max Hops in an MST Region

Operation	Command
Configure the max hops in an MST region.	**stp max-hops** *hop*
Restore the default max hops in an MST region	**undo stp max-hops**

The more the hops in an MST region, the larger the scale of the region. Only the max hops configured on the region root can limit the scale of MST region. Other switches in the MST region also apply the configurations on the region root, even if they have been configured with max hops.

By default, the max hops of an MST is 20.

Configuring the Switching Network Diameter

Any two hosts on the switching network are connected with a specific path carried by a series of switches. Among these paths, the one passing more switches than all others is the network diameter, expressed as the number of passed switches.

You can use the following command to configure the diameter of the switching network.

Perform the following configuration in system view.

Table 8 Configure the Switching Network Diameter

Operation	Command
Configure the switching network diameter.	**stp bridge-diameter** *bridgenum*
Restore the default switching network diameter.	**undo stp bridge-diameter**

The network diameter is the parameter specifying the network scale. The larger the diameter, the larger the scale.

When a user configures the network diameter on a switch, MSTP automatically calculates and sets the hello time, forward-delay time, and maximum-age time, of the switch, to the desirable values.

The setting of the network diameter takes effect on CIST only, but has no effect on MSTI.

By default, the network diameter is 7 and the three corresponding timers take the default values.

Configuring the Time Parameters of a Switch

The switch has three time parameters:

- forward delay,
- hello time,
- and max age.

Forward delay is the switch state transition mechanism. The spanning tree will be recalculated upon link faults and its structure will change accordingly. The configuration BPDU recalculated cannot be immediately propagated throughout the network. Temporary loops can occur if the new root port and designated port forward data, right after being elected. Therefore, the protocol adopts a state transition mechanism. It takes a forward delay interval for the root port and designated port to transit from the learning state to forwarding state. The forward delay guarantees a period of time during which the new configuration BPDU can be propagated throughout the network.

The switch sends a hello packet periodically to check if there is any link fault. The interval in which the hello packet is sent is specified by the hello timer.

Max age specifies when the configuration BPDU expires. The switch will discard the expired configuration BPDU.

You can use the following command to configure the time parameters for the switch.

Perform the following configuration in system view.

Table 9 Configure the Time Parameters of a Switch

Operation	Command
Configure Forward Delay on the switch.	**stp timer forward-delay** *centiseconds*
Restore the default Forward Delay of the switch.	**undo stp timer forward-delay**
Configure Hello Time on the switch.	**stp timer hello** *centiseconds*
Restore the default Hello Time on the switch.	**undo stp timer hello**
Configure Max Age on the switch.	**stp timer max-age** *centiseconds*
Restore the default Max Age on the switch.	**undo stp timer max-age**

Every switch on the switching network adopts the values of the time parameters configured on the root switch of the CIST.

The forward delay configured on a switch depends on the switching network diameter. Generally, the forward delay is supposed to be longer when the network diameter is longer. Note that a forward delay that is too short can redistribute some redundant routes temporarily, while a forward delay that is too long can prolong the network connection resuming. The default value is recommended.

A suitable hello time ensures that the switch can detect the link fault on the network, but also occupy moderate network resources. The default value is recommended. If you set a hello time that is too long, when there is packet dropped over a link, the switch may consider it as link fault and the network device will recalculate the spanning tree accordingly. However, for a hello time that is too short, the switch frequently sends configuration BPDU, which adds burden and wastes the network resources.

A max age that is too short, can cause the network device to calculate the spanning tree frequently and mistake the congestion as a link fault. If the max age is too long, the network device may not be able to discover the link fault and recalculate the spanning tree in time, which weakens the auto-adaptation capacity of the network. The default value is recommended.

To avoid frequent network flapping, the values of hello time, forward delay and maximum age should guarantee the following formulas equal.

2 * (forward-delay - 1seconds) >= maximum-age

maximum-age >= 2 * (hello + 1.0 seconds)

You should use the **stp root primary** command to specify the network diameter and hello time of the switching network so MSTP will calculate automatically and give better values.

By default, forward delay is 15 seconds, hello time is 2 seconds, and max age is 20 seconds.

Configuring the Max Transmission Speed on a Port

The max transmission speed on a port specifies how many MSTP packets will be transmitted, every hello time, through the port.

The max transmission speed on a port is limited by the physical state of the port and the network structure. You can configure it according to the network conditions.

You can configure the max transmission speed on a port in the following ways.

Configuring in system view

Perform the following configuration in system view.

Table 10 Configure the Max Transmission Speed on a Port

Operation	Command
Configure the max transmission speed on a port.	**stp interface** *interface-list* **transit-limit** *packetnum*
Restore the max transmission speed on a port.	**undo stp interface** *interface-list* **transit-limit**

Configuring in Ethernet port view

Perform the following configuration in Ethernet port view.

Table 11 Configure the Max Transmission Speed on a Port

Operation	Command
Configure the max transmission speed on a port.	**stp transit-limit** *packetnum*
Restore the max transmission speed on a port.	**undo stp transit-limit**

For more about the commands, see the *Switch 8800 Command Reference Guide*.

This parameter only takes a relative value without units. If it is set too large, too many packets will be transmitted during every hello time and too many network resources will be occupied. The default value is recommended.

By default, the max transmission speed on every Ethernet port of the switch is 3.

Configuring a Port as an Edge Port

An edge port refers to the port not directly connected to any switch, or indirectly connected to a switch over the connected network.

You can configure a port as an edge port or non-edge port in the following ways.

Configuring in System View

Perform the following configuration in system view.

Table 12 Configure a Port as an Edge Port or a Non-edge Port

Operation	Command
Configure a port as an edge port.	**stp interface** *interface-list* **edged-port enable**
Configure a port as a non-edge port.	**stp interface** *interface-list* **edged-port disable**
Restore the default setting, non-edge port, of the port.	**undo stp interface** *interface-list* **edged-port**

Configuring in Ethernet Port View

Perform the following configuration in Ethernet port view.

Table 13 Configure a Port as an Edge Port or a Non-edge Port

Operation	Command
Configure a port as an edge port.	**stp edged-port enable**
Configure a port as a non-edge port.	**stp edged-port disable**
Restore the default setting, non-edge port, of the port.	**undo stp edged-port**

For more about the commands, see the *Switch 8800 Command Reference Guide.*

After it is configured as an edge port, the port can transit rapidly from a blocking state to a forwarding state without any delay. In the case that BPDU protection has not been enabled on the switch, the configured edge port will turn into non-edge port again when it receives BPDU from the other port. In case BPDU protection is enabled, the port will be disabled. This parameter is configured the same, and takes effect on all the STIs.

*To reenable a port that was disabled by the **stp edged-port disable** command, use the **undo shutdown** command in port view.*

It is better to configure the BPDU protection on the edge port to prevent the switch from being attacked.

Before BPDU protection is enabled on the switch, the port runs as a non-edge port when it receives BPDU, even if the user has set it as an edge port.

By default, all the Ethernet ports of the switch have been configured as non-edge ports.

Configuring the Path Cost of a Port

Path cost is related to the speed of the link connected to the port. On the MSTP switch, a port can be configured with different path costs for different STIs. Thus

the traffic from different VLANs can run over different physical links, thereby implementing the VLAN-based load-balancing.

You can configure the path cost of a port in the following ways.

Configuring in System View

Perform the following configuration in system view.

Table 14 Configure the Path Cost of a Port

Operation	Command
Configure the Path Cost of a port.	**stp interface** *interface-list* **instance** *instance-id* **cost** *cost*
Restore the default path cost of a port.	**undo stp interface** *interface-list* **instance** *instance-id* **cost**

Configuring in Ethernet Port View

Perform the following configuration in Ethernet port view.

Table 15 Configure the Path Cost of a Port

Operation	Command
Configure the Path Cost of a port	**stp instance** *instance-id* **cost** *cost*
Restore the default path cost of a port.	**undo stp instance** *instance-id* **cost**

For more about the commands, see the *Switch 8800 Command Reference Guide*.

Upon the change of path cost of a port, MSTP will recalculate the port role and transit the state. When *instance-id* takes 0, it indicates to set the path cost on the CIST.

By default, MSTP is responsible for calculating the port path cost.

Configuring the Priority of a Port

For spanning tree calculation, the port priority is an important factor when determining if a port can be elected as the root port. With other attributes being equal, the port with the highest priority is elected as the root port. On the MSTP switch, a port can have different priorities in different STIs, and play different roles. The traffic from different VLANs can run over different physical links, thereby implementing the VLAN-based load-balancing.

You can configure the port priority in the following ways.

Configuring in System View

Perform the following configuration in system view.

Table 16 Configure the Port Priority

Operation	Command
Configure the port priority.	**stp interface** *interface-list* **instance** *instance-id* **port priority** *priority*
Restore the default port priority.	**undo stp interface** *interface-list* **instance** *instance-id* **port priority**

Configuring in Ethernet Port View

Perform the following configuration in Ethernet port view.

Table 17 Configure the Port Priority

Operation	Command
Configure the port priority.	**stp instance** *instance-id* **port priority** *priority*
Restore the default port priority.	**undo stp instance** *instance-id* **port priority**

For more about the commands, see the *Switch 8800 Command Reference Guide*.

After the change of port priority, MSTP will recalculate the port role and transit the state. A smaller value represents a higher priority. If all the Ethernet ports of a switch are configured with the same priority value, the priorities of the ports will be differentiated by the index number. The change of Ethernet port priority will lead to spanning tree recalculation. You can configure the port priority with actual networking requirements.

By default, the priority of all the Ethernet ports is 128.

Configuring the Port Connection with the Point-to-Point Link

The point-to-point link directly connects two switches.

You can configure the port to connect or not connect with the point-to-point link in the following ways.

Configuring in System View

Perform the following configuration in system view.

Table 18 Configure the Port Connection With the Point-to-point Link

Operation	Command
Configure the port to connect with the point-to-point link.	**stp interface** *interface-list* **point-to-point force-true**
Configure the port not to connect with the point-to-point link.	**stp interface** *interface-list* **point-to-point force-false**
Configure MSTP to automatically detect if the port is directly connected with the point-to-point link.	**stp interface** *interface-list* **point-to-point auto**
Configure MSTP to automatically detect if the port is directly connected with the point-to-point link, as defaulted.	**undo stp interface** *interface-list* **point-to-point**

Configuring in Ethernet Port View

Perform the following configuration in Ethernet port view.

Table 19 Configure the Port Connection With the Point-to-point Link

Operation	Command
Configure the port to connect with the point-to-point link.	**stp point-to-point force-true**
Configure the port not to connect with the point-to-point link.	**stp point-to-point force-false**
Configure MSTP to automatically detect if the port is directly connected with the point-to-point link.	**stp point-to-point auto**

Table 19 Configure the Port Connection With the Point-to-point Link

Operation	Command
Configure MSTP to automatically detect if the port is directly connected with the point-to-point link, as defaulted.	undo stp point-to-point

For more about the commands, see the *Switch 8800 Command Reference Guide*.

The ports connected with the point-to-point link, upon some port role conditions being met, can transit to forwarding state rapidly through transmitting synchronization packet, thus, reducing the unnecessary forwarding delay. If the parameter is configured in auto mode, MSTP will automatically detect if the current Ethernet port is connected with the point-to-point link.

For a link aggregation, only the master port can be configured to connect with the point-to-point link. If a port in auto-negotiation mode operates in full-duplex mode upon negotiation, it can be configured to connect with the point-to-point link.

This configuration takes effect on the CIST and all the MSTIs. The settings of a port determine whether or not the point-to-point link will be applied to all the STIs to which the port belongs. Note that a temporary loop may be redistributed if you configure a port not physically connected with the point-to-point link, rather, connected to such a link by force.

By default, the parameter is configured as **auto**.

Configuring the mCheck Variable of a Port

The port of an MSTP switch operates in either STP-compatible or MSTP mode.

If a port of an MSTP switch on a switching network is connected to an STP switch, the port will automatically transition to operate in STP-compatible mode. The port stays in STP-compatible mode and cannot automatically transition back to MSTP mode when the STP switch is removed. In this case, you can perform an mCheck operation to transit the port to MSTP mode by force.

You can use the following measures to perform mCheck operation on a port.

Configuring in system view

Perform the following configuration in system view.

Table 20 Configure the mCheck Variable of a Port

Operation	Command
Perform mCheck operation on a port.	**stp interface** *interface-list* **mcheck**

Configuring in Ethernet port view

Perform the following configuration in Ethernet port view.

Table 21 Configure the mCheck Variable of a Port

Operation	Command
Perform mCheck operation on a port.	**stp mcheck**

For more about the commands, see the *Switch 8800 Command Reference Guide*.

The command can be used only if the switch runs MSTP. The command does not make any sense when the switch runs in STP-compatible mode.

Configuring the Switch Security Function

An MSTP switch provides BPDU protection, Root protection, and loop-protection functions.

For an access device, the access port is, mainly, directly connected to the user terminal or a file server, and the access port is set to edge port to implement fast transition. When such a port receives BPDU packet, the system will automatically set it as a non-edge port and recalculate the spanning tree, which causes the network topology flapping. Normally, these ports will not receive STP BPDU. If someone forges BPDU to attack the switch, the network will flap. BPDU protection function is used against such network attacks.

The primary and secondary root switches of the spanning tree, especially those of ICST, must be located in the same region. This is because the primary and secondary roots of CIST are generally placed in the core region with a high bandwidth in network design. In case of configuration error or malicious attack, the legal primary root may receive the BPDU with a higher priority and then lose its place, which causes network topology change errors. Due to the illegal change, the traffic that is supposed to travel over the high-speed link may be pulled to the low-speed link and congestion will occur on the network. The root protection function is used against such problem.

The root port and other blocked ports maintain their state according to the BPDUs sent by an uplink switch. Once the link is blocked or has trouble, the ports cannot receive BPDUs and the switch will select a root port again. In this case, the former root port will turn into a specified port and the former blocked ports will enter the forwarding state and a link loop will be created.

The security functions can control the generation of loop. After it is enabled, the root port cannot be changed, the blocked port will remain in the discarding state and will not forward packets.

You can use the following command to configure the security functions of the switch.

Perform the following configuration in corresponding configuration modes.

Table 22 Configure the Switch Security Function

Operation	Command
Configure switch BPDU protection (from system view)	**stp bpdu-protection**
Restore the disabled BPDU protection state as defaulted (from system view)	**undo stp bpdu-protection**
Configure switch Root protection (from system view)	**stp interface** *interface-list* **root-protection**
Restore the disabled Root protection state as defaulted (from system view)	**undo stp interface** *interface-list* **root-protection**
Configure switch Root protection (from Ethernet port view)	**stp root-protection**
Restore the disabled Root protection state as defaulted (from Ethernet port view)	**undo stp root-protection**

Table 22 Configure the Switch Security Function

Operation	Command
Configure switch loop protection function (from Ethernet port view)	**stp loop-protection**
Restore the disabled loop protection state, as defaulted (from Ethernet port view)	**stp loop-protection**

After configured with BPDU protection, the switch will disable the edge port through MSTP, which receives a BPDU, and notifies the network manager at the same time. These ports can be resumed by the network manager only.

The port configured with root protection only plays the role of designated port on every instance. Whenever such a port receives a higher-priority BPDU, that is, it is about to turn into non-designated port, it will be set to listening state and will not forward packets any more (as if the link to the port is disconnected). If the port has not received any higher-priority BPDU for a certain period of time thereafter, it will resume the normal state.

When you configure a port, only one configuration at a time can be effective among loop protection, root protection, and edge port configuration.

By default, the switch does not enable BPDU protection, root protection, or edge port protection.

For more about the configuration commands, see the *Switch 8800 Command Reference Guide*.

Enabling MSTP on the Device

You can use the following command to enable MSTP on the device.

Perform the following configuration in system view.

Table 23 Enable/Disable MSTP on a Device

Operation	Command
Enable MSTP on a device.	**stp enable**
Disable MSTP on a device.	**stp disable**
Restore the disable state of MSTP, as defaulted.	**undo stp**

Only if MSTP has been enabled on the device will other MSTP configurations take effect.

By default, MSTP is disabled.

Enabling or Disabling MSTP on a Port

You can use the following command to enable or disable MSTP on a port. You may disable MSTP on some Ethernet ports of a switch to spare them from spanning tree calculation. This measure flexibly controls MSTP operation and saves the CPU resources of the switch.

MSTP can be enabled/disabled on a port the following ways.

Configuring in System View

Perform the following configuration in system view.

Table 24 Enable/Disable MSTP on a Port

Operation	Command
Enable MSTP on a port.	**stp interface** *interface-list* **enable**
Disable MSTP on a port.	**stp interface** *interface-list* **disable**
Restore the default MSTP state on the port.	**undo stp** *interface-list*

Configuring in Ethernet Port View

Perform the following configuration in Ethernet port view.

Table 25 Enable/Disable MSTP on a Port

Operation	Command
Enable MSTP on a port.	**stp enable**
Disable MSTP on a port.	**stp disable**
Restore the default MSTP state on the port.	

For more information about the commands, see the *Switch 8800 Command Reference Guide*.

A redundant route may be generated after MSTP is disabled.

By default, MSTP is enabled on all the ports after it is enabled on the device.

Displaying and Debugging MSTP

After you configure MSTP, execute the **display** command in all views to display the operation of the MSTP configuration, and to verify the effect of the configuration. Execute the **reset** command in user view to clear the statistics of MSTP module. Use the **debugging** command in user view to debug the MSTP module

Table 26 Display and Debug MSTP

Operation	Command
Show the configuration information about the current port and the switch.	**display stp instance** *instance-id* [**interface** *interface-list*] [**brief**]
Show the configuration information about the region.	**display stp region-configuration**
Clear the MSTP statistics information.	**reset stp** [**interface** *interface-list*]
Enable/Disable MSTP (packet receiving/transmitting, event, error) debugging on the port.	[**undo**] **debugging stp** [**interface** *interface-list*] { **packet** | **event** }
Enable/Disable the global MSTP debugging.	[**undo**] **debugging stp** { **global-event | global-error | all** }
Enable/Disable specified STI debugging	[**undo**] **debugging stp instance** *instance-id*

9 AAA AND RADIUS OPERATION

This chapter covers the following topics:

- IEEE 802.1x
- Configuring the AAA and RADIUS Protocols

IEEE 802.1x

IEEE 802.1x (hereinafter simplified as 802.1x) is a port-based network access control protocol that is used as the standard for LAN user access authentication.

In LANs that comply with IEEE 802 standards, the user can access devices and share resources in the LAN by connecting a device such as a LAN Switch. In telecom access, commercial LAN (a typical example is the LAN in the office building) and mobile office, etc., the LAN providers generally aim to control the user's access. The requirement on the above-mentioned "port-based network access control" is the most applicable.

As the name implies, "port-based network access control" means to authenticate and control all accessed devices on the port of the device. If the user's device can pass authentication, the user can access resources in the LAN.

802.1x defines port based network access control protocol, and the point-to-point connection between the access device and the access port, only. The port can be either physical or logical. A typical application environment is as follows: Each physical port of the LAN Switch only connects to one user workstation (based on the physical port) and the wireless LAN access environment (based on the logical port), etc.

Configuring IEEE 802.1x is described in the following sections:

- 802.1x System Architecture
- Configuring 802.1x

802.1x System Architecture

The system using 802.1x is a typical C/S (Client/Server) system architecture. It contains three entities, Supplicant System, Authenticator System and Authentication Server System.

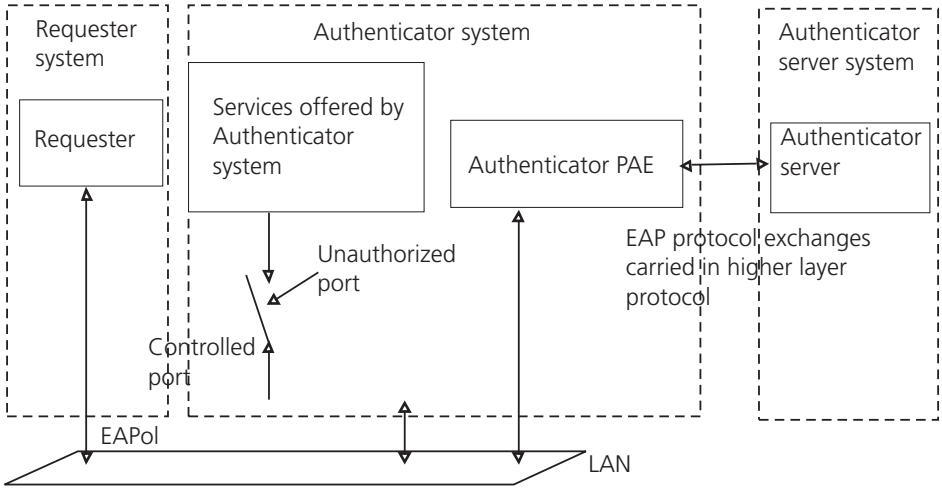
The LAN access control device needs to provide the Authenticator System of 802.1x. The computers need to be installed with the 802.1x client Supplicant software, for example, the 802.1x client provided by Microsoft Windows XP. The 802.1x Authentication Server system normally stays in the carrier's AAA center.

Authenticator and Authentication Server exchange information through EAP (Extensible Authentication Protocol) frames. The Supplicant and the Authenticator exchange information through the EAPoL (Extensible Authentication Protocol over

LANs) frame defined by IEEE 802.1x. Authentication data are encapsulated in the EAP frame, which is encapsulated in packets of other AAA upper layer protocols (e.g. RADIUS). This provides a channel through the complicated network to the Authentication Server. Such procedure is called EAP Relay.

There are two types of ports for the Authenticator. One is the Uncontrolled Port, and the other is the Controlled Port. The Uncontrolled Port is always in a bi-directional connection state. The user can access and share the network resources any time through the ports. The Controlled Port will be in a connecting state only after the user passes the authentication. Then the user is allowed to access the network resources.

Figure 1 802.1x System Architecture



Tasks for configuring 802.1x System Architecture is described in the following sections:

- 802.1x Authentication Process
- Implementing 802.1x on the Switch 8800

802.1x Authentication Process

802.1x configures EAP frame to carry the authentication information. The Standard defines the following types of EAP frames:

- EAP-Packet: Authentication information frame, used to carry the authentication information.
- EAPoL-Start: Authentication originating frame, actively originated by the Supplicant.
- EAPoL-Logoff: Logoff request frame, actively terminating the authenticated state.
- EAPoL-Key: Key information frame, supporting to encrypt the EAP packets.
- EAPoL-Encapsulated-ASF-Alert: Supports the Alerting message of Alert Standard Forum (ASF).

The EAPoL-Start, EAPoL-Logoff, and EAPoL-Key only exist between the Supplicant and the Authenticator. The EAP-Packet information is re-encapsulated by the Authenticator System and then transmitted to the Authentication Server System.

The EAPoL-Encapsulated-ASF-Alert is related to the network management information and terminated by the Authenticator.

802.1x provides an implementation solution of user ID authentication. However, 802.1x itself is not enough to implement the scheme. The administrator of the access device should configure the AAA scheme by selecting RADIUS or local authentication to assist 802.1x in implementing the user ID authentication. For a detailed description, refer to the corresponding AAA configuration.

Implementing 802.1x on the Switch 8800

The 3Com Switch 8800 not only supports the port access authentication method regulated by 802.1x, but also extends and optimizes it in the following way:

- Support to connect several End Stations in the downstream by a physical port.
- The access control (or the user authentication method) can be based on port or MAC address.

In this way, the system becomes more secure, and easier to manage.

Configuring 802.1x

The configuration tasks of 802.1x itself, can be fulfilled in system view of the Ethernet switch. When the global 802.1x is not enabled, the user can configure the 802.1x state of the port. The configured items will take effect after the global 802.1x is enabled.

Do not enable 802.1x and RSTP at the same time or the switch may not work normally.

The 802.1x configuration tasks are described in the following sections:

- Enabling/Disabling 802.1x
- Setting the Port Access Control Mode
- Setting Port Access Control Method
- Checking the Users that Log on the Switch by Proxy
- Setting Number of Users on a Port
- Enabling DHCP to Launch Authentication
- Configuring the Authentication Method for 802.1x Users
- Setting the Maximum Retransmission Times
- Setting the Handshake Period of 802.1x
- Configuring Timers
- Enabling/Disabling Quiet-Period Timer
- Displaying and Debugging 802.1x

Enabling/Disabling 802.1x

The following commands can be used to enable/disable the 802.1x on the specified port. When no port is specified in system view, the 802.1x is enabled/disabled globally.

Perform the following configurations in system view or Ethernet port view.

Table 1 Enable/Disable 802.1x

Operation	Command
Enable the 802.1x	**dot1x** [**interface** *interface-list*]
Disable the 802.1x	**undo dot1x** [**interface** *interface-list*]

User can configure 802.1x on an individual port. The configuration will take effect right after 802.1x is enabled globally.

By default, 802.1x authentication has not been enabled globally, or on any port.

Setting the Port Access Control Mode

The following commands can be used for setting 802.1x access control mode on the specified port. When no port is specified, the access control mode of all ports is configured.

Perform the following configurations in system view or Ethernet port view.

Table 2 Set the Port Access Control Mode

Operation	Command
Set the port access control mode.	**dot1x port-control** {**authorized- force	unauthorized-force	auto**} [**interface** *interface-list*]
Restore the default access control mode of the port.	**undo dot1x port-control** [**interface** *interface-list*]

By default, access control on the port is auto (automatic identification mode, which is also called protocol control mode). That is, the initial state of the port is unauthorized. It only permits EAPoL packets receiving/transmitting, and does not permit the user to access the network resources. If the authentication flow is passed, the port will be switched to the authorized state and permit the user to access the network resources; this is most common.

Setting Port Access Control Method

The following commands are used for setting 802.1x access control method on the specified port. When no port is specified in system view, the access control method of the port is configured globally.

Perform the following configurations in system view or Ethernet port view.

Table 3 Set Port Access Control Method

Operation	Command
Set port access control method	**dot1x port-method** {**macbased**	**portbased**} [**interface** *interface-list*]
Restore the default port access control method	**undo dot1x port-method** [**interface** *interface-list*]

By default, 802.1x authentication method on the port is MAC-based. That is, authentication is performed based on MAC addresses.

Checking the Users that Log on the Switch by Proxy

The following commands are used for checking the users that log on by proxy.

Perform the following configurations in system view or Ethernet port view.

Table 4 Check the Users that Log on the Switch by Proxy

Operation	Command
Enable the check for access users by proxy	**dot1x supp-proxy-check** {**logoff** | **trap**} [**interface** *interface-list*]
Cancel the check for access users by proxy	**undo dot1x supp-proxy-check** {**logoff** | **trap**} [**interface** *interface-list*]

Setting Number of Users on a Port

The following commands are used for setting the number of users allowed by 802.1x on a specified port. When no port is specified, all the ports accept the same number of users.

Perform the following configurations in system view or Ethernet port view.

Table 5 Set Maximum Number of Users by Specified Port

Operation	Command
Set maximum number of users by specified port	**dot1x max-user** *user-number* [**interface** *interface-list*]
Restore the maximum number of users on the port to the default value	**undo dot1x max-user** [**interface** *interface-list*]

By default, 802.1x allows up to 2048 supplicants on each port for Switch 8800

Enabling DHCP to Launch Authentication

When the user runs DHCP and applies for dynamic IP addresses, use the following commands to set whether or not 802.1x will enable the Ethernet switch to launch the user ID authentication.

Perform the following configurations in system view.

Table 6 Set to Enable DHCP to Launch Authentication

Operation	Command
Enable DHCP to launch authentication	**dot1x dhcp-launch**
Disable DHCP to launch authentication	**undo dot1x dhcp-launch**

By default, authentication will not be launched when the user runs DHCP and applies for dynamic IP addresses.

Configuring the Authentication Method for 802.1x Users

The following commands can be used to configure the authentication method for 802.1x users. Three kinds methods of authentication are available:

- PAP — the Remote Authentication Dial-In User Service (RADIUS) server must support this method
- CHAP — the RADIUS server must support this method

- EAP relay — the switch sends authentication information to the RADIUS server in the form of EAP packets, directly, so that the RADIUS server never supports EAP authentication

Perform the following configurations in system view.

Table 7 Configure the Authentication Method for 802.1x Users

Operation	Command
Configure the authentication method for 802.1x users	**dot1x authentication-method** { **chap** | **pap** | **eap md5-challenge**}
Restore the default authentication method for 802.1x users	**undo dot1x authentication-method**

Setting the Maximum Retransmission Times

The following commands are used for setting the maximum authenticator-to-supplicant frame-retransmission times.

Perform the following configurations in system view.

Table 8 Set the Maximum Retransmission Times

Operation	Command
Set the maximum retransmission times	**dot1x retry** *max-retry-value*
Restore the default maximum retransmission times	**undo dot1x retry**

By default, the max-retry-value is 3. That is, the switch can retransmit the authentication request frame to a supplicant 3 times at most.

Setting the Handshake Period of 802.1x

The following commands are used to set the handshake period of 802.1x. After setting the handshake-period, the system will send the handshake packets by the period set. If the dot1x retry time is configured as N, the system considers the user logged off and sets the user in logoff stat if it does not receive a response from the user N times, consecutively.

Perform the following configurations in system view.

Table 9 Set the Handshake Period of 802.1x

Operation	Command
Set the handshake period of 802.1x	**dot1x timer handshake-period** *interval*
Restore the handshake period to the default value	**undo dot1x timer handshake-period**

By default, the handshake period is 15 seconds.

Configuring Timers

The following commands are used for configuring the 802.1x timers.

Perform the following configurations in system view.

Table 10 Configure Timers

Operation	Command
Configure timers	**dot1x timer** {**quiet-period** *quiet-period-value* | **tx-period** *tx-period-value* | **supp-time-out** *supp-timeout-value* | **server-timeout** *server-timeout-value*}
Restore default settings of the timers	**undo dot1x timer** {**quiet-period** | **tx-period** | **supp-timeout** | **server-timeout**}

quiet-period: Specify the quiet timer. If an 802.1x user has not passed the authentication, the Authenticator will keep quiet for a while (which is specified by **quiet-period** timer) before launching the authentication again. During the quiet period, the Authenticator does not do anything related to 802.1x authentication.

quiet-period-value: Specify how long the quiet period is. The value ranges from 10 to 120 in units of second.

server-timeout: Specify the timeout timer of an Authentication Server. If an Authentication Server has not responded before the specified period expires, the Authenticator will resend the authentication request.

server-timeout-value: Specify how long the duration is, of a timeout timer of an Authentication Server. The value ranges from 100 to 300 in units of second.

supp-timeout: Specify the authentication timeout timer of a Supplicant. If a Supplicant has not responded before the specified period expires, Authenticator will resend the authentication request.

supp-timeout-value: Specify how long the duration of an authentication timeout timer of a Supplicant is. The value ranges from 10 to 120 in units of second.

tx-period: Specify the transmission timeout timer. If a Supplicant has not responded before the specified period expires, Authenticator will resend the authentication request.

tx-period-value: Specify how long the duration of the transmission timeout timer is. The value ranges from 10 to 120 in units of second.

By default, the *quiet-period-value* is 60 seconds, the *tx-period-value* is 30 seconds, the *supp-timeout-value* is 30 seconds, the *server-timeout-value* is 100 seconds.

Enabling/Disabling Quiet-Period Timer

You can use the following commands to enable/disable a quiet-period timer of the Switch 8800. If an 802.1x user has not passed authentication, the Authenticator will keep quiet (specified by **quiet-period**) before launching the authentication again. During the quiet period, the Authenticator does not do anything related to 802.1x authentication.

Perform the following configuration in system view.

Table 11 Enable/Disable a Quiet-Period Timer

Operation	Command
Enable a quiet-period timer.	**dot1x quiet-period**
Disable a quiet-period timer	**undo dot1x quiet-period**

Displaying and Debugging 802.1x

Execute the **display** command in all views to display the VLAN configuration, and to verify the configuration. Execute the **reset** command in user view to reset 802.1x statistics information. Execute the **debugging** command in user view to debug the 802.1x module.

Table 12 Display and Debug 802.1x

Operation	Command
Display the configuration, operational and statistics information of 802.1x	**display dot1x** [**sessions** | **statistics**] [**interface** *interface-list*]
Reset the 802.1x statistics information	**reset dot1x statistics** [**interface** *interface-list*]
Enable the error/event/packet/all debugging of 802.1x	**debugging dot1x** {**error** | **event** | **packet** | **all**}
Disable the error/event/packet/all debugging of 802.1x.	**undo debugging dot1x** {**error | event | packet | all**}

Example: 802.1x Configuration

As shown in the following figure, the workstation is connected to the 1/1/2 of the Switch 8800.

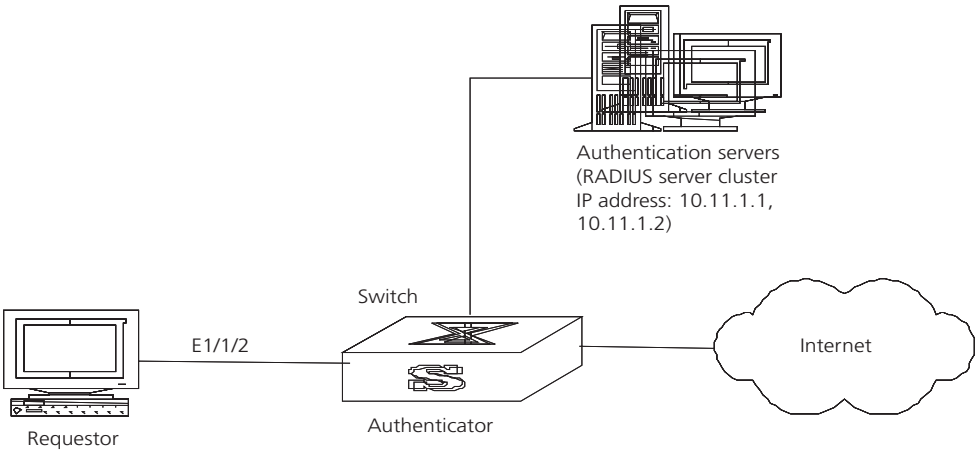
The switch administrator will enable 802.1x on all the ports to authenticate the supplicants in order to control their access to the Internet. The access control mode is based on the MAC address.

All the supplicants belong to the default domain 3com163.net, which can contain up to 30 users. RADIUS authentication is performed first. If there is no response from the RADIUS server, local authentication will be performed. For accounting, if the RADIUS server fails to account, the user will be disconnected. In addition, when the user is connected, the domain name does not follow the user name. Normally, if the user's traffic is less than 2kbps, consistently, over a period of 20 minutes, they will be disconnected.

A server group, consisting of two RADIUS servers at 10.11.1.1 and 10.11.1.2, is connected to the switch. The former one acts as the primary-authentication/second-accounting server. The latter one acts as the secondary-authentication/primary-accounting server. Set the encryption key as "name" when the system exchanges packets with the authentication RADIUS server, and "money" when the system exchanges packets with the accounting RADIUS server. Configure the system to retransmit packets to the RADIUS server if no response is received in 5 seconds. Retransmit the packet no more than 5 times in all. Configure the system to transmit a real-time accounting packet to the RADIUS server every 15 minutes. The system is instructed to transmit the user name to the RADIUS server after removing the user domain name.

The user name of the local 802.1x access user is localuser and the password is localpass (input in plain text). The idle cut function is enabled.

Figure 2 Enabling 802.1x and RADIUS to Perform AAA on the Requester



The following examples concern most of the AAA/RADIUS configuration commands. The configurations for accessing user workstation and the RADIUS server are omitted.

1 Enable the 802.1x performance on the specified port GigabitEthernet1/1/2.

```
[SW8800]dot1x interface GigabitEthernet1/1/2
```

2 Set the access control mode. (This command could not be configured, when it is configured as MAC-based by default.)

```
[SW8800]dot1x port-method macbased interface GigabitEthernet1/1/2
```

3 Create the RADIUS group radius1 and enters its configuration mode.

```
[SW8800]radius scheme radius1
```

4 Set the IP address of the primary authentication/accounting RADIUS servers.

```
[SW8800-radius-radius1]primary authentication 10.11.1.1 1812
[SW8800-radius-radius1]primary accounting 10.11.1.1 1813
```

5 Set the IP address of the second authentication/accounting RADIUS servers.

```
[SW8800-radius-radius1]secondary authentication 10.11.1.2 1812
[SW8800-radius-radius1]secondary accounting 10.11.1.2 1813
```

6 Set the encryption key when the system exchanges packets with the authentication RADIUS server.

```
[SW8800-radius-radius1]key authentication a123456789
```

7 Set the encryption key when the system exchanges packets with the accounting RADIUS server.

```
[SW8800-radius-radius1]key accounting m123456789
```

8 Set the timeouts and times for the system to retransmit packets to the RADIUS server.

```
[SW8800-radius-radius1]timer 5
[SW8800-radius-radius1]retry 5
```

9 Set the interval for the system to transmit real-time accounting packets to the RADIUS server.

```
[SW8800-radius-radius1]timer realtime-accounting 15
```

10 Configure the system to transmit the user name to the RADIUS server after removing the domain name.

```
[SW8800-radius-radius1]user-name-format without-domain
[SW8800-radius-radius1]quit
```

11 Create the user domain 3com163.net and enters isp configuration mode.

```
[SW8800]domain 3com163.net
```

12 Specify radius1 as the RADIUS server group for the users in the domain 3com163.net.

```
[SW8800-isp-3com163.net]radius-scheme radius1
```

13 Set a limit of 30 users to the domain 3com163.net.

```
[SW8800-isp-3com163.net]access-limit enable 30
```

14 Enable idle cut function for the user and set the idle cut parameter in the domain 3com163.net.

```
[SW8800-isp-3com163.net]idle-cut enable 50 5000
```

15 Add a local supplicant and sets its parameter.

```
[SW8800]local-user localuser
[SW8800-luser-localuser]attribute service-type lan-access
[SW8800-luser-localuser]password simple localpass
```

16 Enable the 802.1x globally.

```
[SW8800]dot1x
```

Configuring the AAA and RADIUS Protocols

The Authentication, Authorization, and Accounting (AAA) protocol provides a uniform framework for configuring these three security functions and implements network security management.

The network security mentioned here refers to access control, including:

- Which user can access the network server
- Which service can the authorized user enjoy
- How to keep accounts for the user who is using network resource

AAA provides the following services:

- Authenticates whether the user can access the network server.
- Authorizes the user with specified services.
- Accounts for network resources that are consumed by the user.

Generally, by applying client/server architecture, AAA framework boasts the following advantages:

- Good scalability.
- Ability to use standard authentication schemes.
- Easy control, and convenient for centralized management of user information.
- Ability to use multiple-level backup systems to enhance the security of the whole framework.

As mentioned above, AAA is a management framework, so it can be implemented by some protocols. RADIUS is frequently used.

Remote Authentication Dial-In User Service, RADIUS for short, is distributed information switching protocol in Client/Server architecture. RADIUS can prevent the network from an interruption of unauthorized access, and it is often used in the network environments requiring both high security and remote user access. For example, it is often used for managing a large number of scattering dial-in users who use serial ports and modems. RADIUS system is the important auxiliary part of Network Access Server (NAS).

After RADIUS system is started, if the user wants to access other networks or use network resources through connection to NAS (dial-in access server in PSTN environment or Ethernet switch with access function in Ethernet environment), NAS, namely RADIUS client end and will transmit user AAA request to the RADIUS server. RADIUS server has a user database recording all the information of user authentication and network services. When receiving user's request from NAS, RADIUS server performs AAA through user database query and update, and returns the configuration information and accounting data to NAS. NAS then controls supplicant and corresponding connections, while RADIUS protocol regulates how to transmit configuration and accounting information between NAS and RADIUS.

NAS and RADIUS exchange the information with UDP packets. During the interaction, both sides encrypt the packets with keys before uploading user configuration information (like password etc.) to avoid being intercepted or stolen.

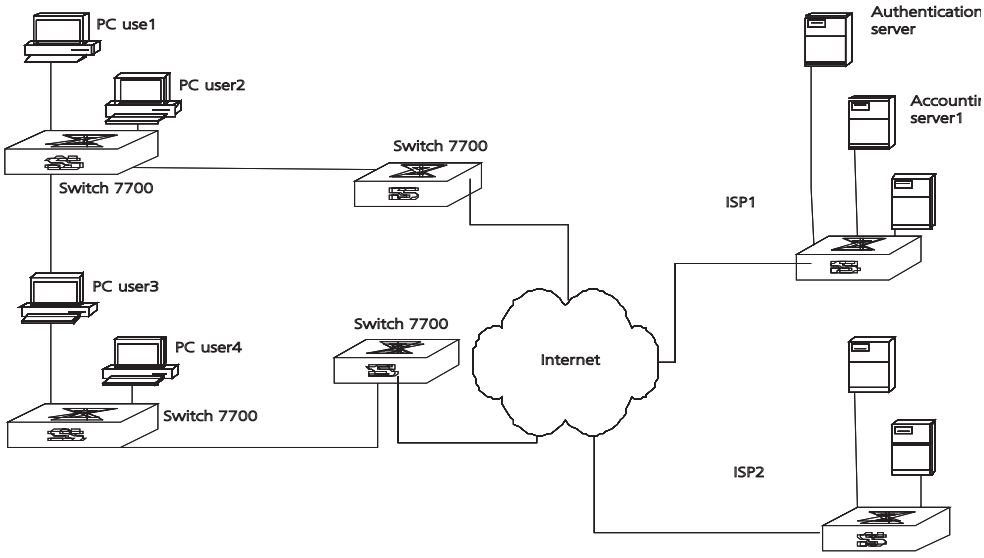
RADIUS server generally uses a proxy function of the devices, like access server, to perform user authentication. The operation process is as follows:

1. Send client username and encrypted password to RADIUS server.
2. User receives one of the following response messages:
   - ACCEPT: Indicates that the user has passed the authentication
   - REJECT: Indicates that the user has not passed the authentication and needs to input username and password again, otherwise he will be rejected from access.

Implementing AAA/RADIUS on the Switch 8800

By now, we understand that in the Switch 8800, serving as the user access device or NAS, is the client end of RADIUS. In other words, the AAA/RADIUS concerning client-end is implemented on The Switch 8800. The figure below illustrates the RADIUS authentication network.

Figure 3 Networking with Switch 8800 Applying RADIUS Authentication



Configuring the AAA and RADIUS Protocols is described in the following sections:

- Configuring AAA
- Configuring the RADIUS Protocol
- Troubleshooting AAA and RADIUS

Configuring AAA

AAA configuration includes tasks that are described in the following sections:

- Creating or Deleting an Internet Service Provider (ISP) Domain
- Configuring Relevant Attributes of an ISP Domain
- Creating a Local User
- Setting Attributes of a Local User
- Disconnecting a User by Force

Among the above configuration tasks, creating an ISP domain is required, otherwise the supplicant attributes cannot be distinguished. The other tasks are optional. You can configure them at requirements.

Creating or Deleting an Internet Service Provider (ISP) Domain

An Internet Service Provider (ISP) domain is a group of users who belong to the same ISP. Taking gw20010608@3com163.net as an example in the userid@isp-name format, the isp-name (i.e. 3com163.net) following the @ is the ISP domain name. When the Switch 8800 control user access, as for an ISP user whose username is in userid@isp-name format, the system will take userid part as username for identification and take isp-name part as domain name.

The purpose of introducing ISP domain settings is to support the multi-ISP application environment. In such an environment, one access device might access users of different ISP. Because the attributes of ISP users, such as username and password formats, etc., may be different, it is necessary to differentiate them by setting ISP domain. In the Switch 8800 ISP domain view, you can configure a

complete set of exclusive ISP domain attributes on a per-ISP domain basis, which includes AAA policy (RADIUS server group applied etc.)

For the Switch 8800, each supplicant belongs to an ISP domain. Up to 16 domains can be configured in the system. If a user has not reported its ISP domain name, the system will put it into the default domain.

Perform the following configurations in system view.

Table 13 Create/Delete ISP Domain

Operation	Command
Create ISP domain or enter the view of a specified domain.	**domain** [*isp-name* | **default** {**disable** | **enable** *isp-name*}]
Remove a specified ISP domain	**undo domain** *isp-name*

By default, domain named *system* has been created in the system. The attributes of *system* are all default values.

Configuring Relevant Attributes of an ISP Domain

The relevant attributes of ISP domain include the adopted RADIUS server group, state, and maximum number of supplicants. Where,

- The adopted RADIUS server group is the one used by all the users in the ISP domain. The RADIUS server group can be used for RADIUS authentication or accounting. By default, the default RADIUS server group is used. The command is used together with the commands of setting RADIUS server and server cluster. For details, refer to "Configuring the RADIUS Protocol ".
- Every ISP has active/block states. If an ISP domain is in active state, the users can request for network service, while in block state, users cannot request any network service. An ISP is in the block state when it is created.
- Maximum number of supplicants specifies how many supplicants can be contained in the ISP. By default, for any ISP domain, there is no limit to the number of supplicants.
- The idle cut function means that if the traffic from a certain connection is lower than the defined traffic, cut off the connection.

Perform the following configurations in ISP domain view.

Table 14 Configure Relevant Attributes of ISP Domain

Operation	Command
Specify the adopted RADIUS server group	**radius-scheme** *radius-scheme-name*
Specify the ISP domain state to be used	**state** {**active** | **block**}
Set a limit to the amount of supplicants	**access-limit** {**disable** | **enable** *max-user-number*}
Set the idle	**idle-cut** {**disable** | **enable** *minute* flow}

By default, after an ISP domain is created, the used RADIUS server group is the default named *system* (for relevant parameter configuration, refer to "Configuring the RADIUS Protocol "), the state of domain is **active**, there is no limit to the amount of supplicants, and the idle-cut is **disabled**.

Creating a Local User

A local user is a group of users set on NAS. The username is the unique identifier of a user. A supplicant requesting network service may use local authentication only if its corresponding local user has been added onto NAS.

Perform the following configurations in system view.

Table 15 Create/Delete a Local User and Relevant Properties

Operation	Command
Add local users	**local-user** *user-name*
Delete all the local users	**undo local-user all**
Delete a local user by specifying its type	**undo local-user** { *user-name* | **all** [**service-type** {**lan-access** | **ftp** | **telnet** }]}

By default, there is no local user in the system.

Setting Attributes of a Local User

The attributes of a local user include its password, state, service type and other settings.

Perform the following configurations in system view.

Table 16 Set the Method that a Local User Uses to Set Password

Operation	Command
Set the method that a local user uses to set password	**local-user password-display-mode** { **cipher-force** | **auto**}
Cancel the method that the local user uses to set password	**undo local-user password-display-mode**

Auto means that the password display mode will be the one specified by the user at the time of configuring a password (see the **password** command in the following table for reference), and **cipher-force** means that the password display mode of all the accessing users must be in cipher text.

Perform the following configurations in local user view.

Table 17 Set/Remove the Attributes Concerned with a Specified User

Operation	Command
Set a password for a specified user	**password** {**simple** | **cipher**} *password*
Remove the password set for the specified user	**undo password**
Set the state of the specified user	**state** {**active** | **block**}
Disable the state of the specified user	**undo state** {**active** | **block**}
Set a service type for the specified user	**service-type** { **ftp** [**ftp-directory** *directory*] | **lan-access** | **telnet** [**level** *level*]] | **telnet** [**level** *level*] }
Cancel the service type of the specified user	undo service-type { telnet [level] | ftp [ftp-directory] | lan-access }

Table 17 Set/Remove the Attributes Concerned with a Specified User

Operation	Command
Configure the attributes of lan-access users	**attribute** {**ip** *ip-address* | **mac** *mac-address* | **idle-cut** *second* | **access-limit** *max-user-number* | **vlan** *vlanid* | **location** { **nas-ip** *ip-address* **port** *portnum* | **port** *portnum* }*
Remove the attributes defined for the lan-access users	**undo attribute** {**ip** | **mac** | **idle-cut** | **access-limit** | **vlan** | **location** }

Disconnecting a User by Force

Sometimes it is necessary to disconnect a user or a category of users by force. The system provides the following command to serve this purpose.

Perform the following configurations in system view.

Table 18 Disconnect a User by Force

Operation	Command
Disconnect a user by force	**cut connection** {**all | access-type {dot1x | gcm} | domain** *domain-name* | **interface** *portnum* | **ip** *ip-address* | **mac** *mac-address* | **radius-scheme** *radius-scheme-name* | **vlan** *vlanid* | **ucibindex** *ucib-index* | **user-name** *user-name* }

By default, no online user will be disconnected by force.

Configuring the RADIUS Protocol

On the Switch 8800, the RADIUS protocol is configured per RADIUS server group basis. In a real networking environment, a RADIUS server group can be an independent RADIUS server or a set of primary/secondary RADIUS servers with the same configuration but two different IP addresses. Attributes of every RADIUS server group include IP addresses of primary and secondary servers, shared key and RADIUS server type, etc.

RADIUS protocol configuration only defines some necessary parameters using information for interaction between NAS and RADIUS Server. To make these parameters effective, it is necessary to configure, in the view, an ISP domain to use the RADIUS server group, and specify it to use RADIUS AAA schemes. For more about the configuration commands, refer to "Configuring AAA ".

Tasks for configuring RADIUS are described in the following sections:

- Creating/Deleting a RADIUS Server Group
- Setting the IP Address and Port Number of RADIUS Server
- Setting the RADIUS Packet Encryption Key
- Setting the Response Timeout Timer of RADIUS Server
- Setting Retransmission Times of the RADIUS Request Packet
- Enabling the Selection of the RADIUS Accounting Option
- Setting a Real-time Accounting Interval
- Setting Maximum Times of Real-time Accounting Request
- Enabling/Disabling Stop Accounting Request Buffer

- Setting the Maximum Retransmitting Times of the Stop Accounting Request
- Setting the Supported Type of RADIUS Server
- Setting RADIUS Server State
- Setting Username Format Transmitted to RADIUS Server
- Setting the Unit of Data Flow that Transmitted to RADIUS Server
- Configuring a Local RADIUS Server Group
- Displaying and Debugging the AAA and RADIUS Protocols
- Configuring FTP/Telnet User Authentication at Remote RADIUS Server
- Configuring FTP/Telnet User Authentication at the Local RADIUS Server

Among the above tasks, creating RADIUS server group, and setting IP address of the RADIUS server are required, while other takes are optional and can be performed per your requirements.

Creating/Deleting a RADIUS Server Group

As mentioned above, RADIUS protocol configurations are performed on the per RADIUS server group basis. Therefore, before performing other RADIUS protocol configurations, it is compulsory to create the RADIUS server group and enter its view to set its IP address.

You can use the following commands to create/delete a RADIUS server group.

Perform the following configurations in system view.

Table 19 Create/Delete a RADIUS Server Group

Operation	Command
Create a RADIUS server group and enter its view	**radius scheme** *radius-server-name*
Delete a RADIUS server group	**undo radius scheme** *radius-server-name*

Several ISP domains can use a RADIUS server group at the same time.

By default, the system has a RADIUS server group named *system* whose attributes are all default values. The default attribute values are introduced in the following section.

Setting the IP Address and Port Number of RADIUS Server

After creating a RADIUS server group, you set IP addresses and UDP port numbers for the RADIUS servers, including primary/second authentication/authorization servers and accounting servers. You can configure up to 4 groups of IP addresses and UDP port numbers. However, you have to set one group of IP address' and UDP port numbers for each pair of primary/second servers to ensure the normal AAA operation.

Perform the following configurations in RADIUS server group view.

Table 20 Set IP Address and Port Number of RADIUS Server

Operation	Command
Set IP address and port number of primary RADIUS authentication/authorization server.	**primary authentication** *ip-address* [*port-number*]
Restore IP address and port number of primary RADIUS authentication/authorization or server to the default values.	**undo primary authentication**
Set IP address and port number of primary RADIUS accounting server.	**primary accounting** *ip-address* [*port-number*]
Restore IP address and port number of primary RADIUS accounting server or server to the default values.	**undo primary accounting**
Set IP address and port number of secondary RADIUS authentication/authorization server.	**secondary authentication** *ip-address* [*port-number*]
Restore IP address and port number of second RADIUS authentication/authorization or server to the default values.	**undo secondary authentication**
Set IP address and port number of second RADIUS accounting server.	**Secondary accounting** *ip-address* [*port-number*]
Restore IP address and port number of second RADIUS accounting server or server to the default values.	**undo secondary accounting**

In real networking environments, the above parameters should be set according to the specific requirements. For example, you may specify 4 groups of different data to map 4 RADIUS servers, or specify one of the two servers as primary authentication/authorization server and second accounting server and the other one as second authentication/authorization server and primary accounting server. You may also set 4 groups of exactly the same data so that every server serves as a primary and second AAA server.

To guarantee the normal interaction between NAS and RADIUS server, you are supposed to guarantee the normal routes between RADIUS server and NAS before setting IP address and UDP port of the RADIUS server. Because RADIUS protocol uses different UDP ports to receive/transmit authentication/authorization and accounting packets, you should set two different ports accordingly. Suggested by RFC2138/2139, the authentication/authorization port number is 1812 and the accounting port number is 1813. However, you may use values other than the ones suggested. (Especially for some earlier RADIUS Servers, authentication/authorization port number is often set to 1645 and accounting port number is 1646.)

The RADIUS service port settings on the Switch 8800 need to be consistent with the port settings on the RADIUS server. Normally, RADIUS accounting service port is 1813 and the authentication/authorization service port is 1812.

By default, all the IP addresses of primary/second authentication/authorization and accounting servers are 0.0.0.0, authentication/authorization service port is 1812 and accounting service UDP port is 1813.

Setting the RADIUS Packet Encryption Key

RADIUS client (switch system) and RADIUS server use MD5 algorithm to encrypt the exchanged packets. The two ends verify the packet by setting the encryption key. Only when the keys are identical can both ends accept the packets from each other and give a response.

Perform the following configurations in RADIUS server group view.

Table 21 Set RADIUS Packet Encryption Key

Operation	Command
Set RADIUS authentication/authorization packet encryption key	**key authentication** *string*
Restore the default RADIUS authentication/authorization packet encryption key.	**undo key authentication**
Set RADIUS accounting packet key	**key accounting** *string*
Restore the default RADIUS accounting packet key	**undo key accounting**

Setting the Response Timeout Timer of RADIUS Server

RADIUS (authentication/authorization or accounting) request packet is transmitted for a specific period of time. If NAS has not received the response from RADIUS server, it has to retransmit the request to guarantee RADIUS service for the user.

Perform the following configurations in RADIUS server group view.

Table 22 Set Response Timeout Timer of RADIUS Server

Operation	Command
Set response timeout timer of RADIUS server	**timer** *second*
Restore the response timeout timer of RADIUS server to default value	**undo timer**

By default, timeout timer of RADIUS server is 3 seconds.

Setting Retransmission Times of the RADIUS Request Packet

Since RADIUS protocol uses UDP packets to carry the data, the communication process is not reliable. If the RADIUS server has not responded to NAS before timeout, NAS has to retransmit the RADIUS request packet. If it transmits the packet for more than retry-time, and RADIUS server still has not given any response, NAS considers the communication with the current RADIUS server disconnected and will transmit the request packet to other RADIUS servers.

Perform the following configurations in RADIUS server group view.

Table 23 Set Retransmission Times of RADIUS Request Packet

Operation	Command
Set retransmission times of RADIUS request packet	**retry** *retry-time*
Restore the default value of retransmission times	**undo retry**

By default, RADIUS request packet will be retransmitted up to three times.

Enabling the Selection of the RADIUS Accounting Option

If no RADIUS server is available or if RADIUS accounting server fails when the accounting optional is configured, the user can still use the network resource, otherwise, the user will be disconnected.

Perform the following configurations in RADIUS server group view.

Table 24 Enable the Selection of the RADIUS Accounting Option

Operation	Command
Enable the selection of the RADIUS accounting option	**accounting optional**
Disable the selection of the RADIUS accounting option	**undo accounting optional**

The user configured with **accounting optional** command in RADIUS scheme longer sends a real-time accounting update packet or offline accounting packet.

The **accounting optional** command in a RADIUS server group view is only effective on the accounting that uses this RADIUS server group.

By default, selection of RADIUS accounting option is disabled.

Setting a Real-time Accounting Interval

To implement this feature, it is necessary to set a real-time accounting interval. After the attribute is set, NAS will transmit the accounting information of online users to the RADIUS server regularly.

Perform the following configurations in RADIUS server group view.

Table 25 Set a Real-Time Accounting Interval

Operation	Command
Set a real-time accounting interval	**timer realtime-accounting** *minute*
Restore the default value of the interval	**undo timer realtime-accounting**

The *minute* variable specifies the real-time accounting interval in minutes. The value must be a multiple of 3.

The value of *minute* is related to the performance of NAS and RADIUS server. The smaller the value is, the higher the performances of NAS and RADIUS have to be. When there are a large amount of users (more than 1000, inclusive), we suggest a larger value. The following table recommends the ratio of *minute* value to the number of users.

Table 26 Recommended Ratio of Minute to Number of Users

Number of users	Real-time accounting interval (minute)
1 to 99	3
100 to 499	6
500 to 999	12
1000	15

By default, *minute* is set to 12 minutes.

Setting Maximum Times of Real-time Accounting Request

The RADIUS server usually verifies that a user is online with timeout timer. If the RADIUS server has not received the real-time accounting packet from NAS for a specified period, it stops accounting. Therefore, it may be necessary to disconnect the user at the NAS end and on the RADIUS server when some unpredictable failure exists. The Switch 8800 allows you to configure the maximum number of retries for real-time accounting requests. NAS disconnects the user if it has not received a real-time accounting response from the RADIUS server for the specified number of times.

Perform the following configurations in RADIUS server group view.

Table 27 Set Maximum Times of Real-Time Accounting Request Failing to be Responded

Operation	Command
Configure the maximum number of retries for real-time accounting requests.	**retry realtime-accounting** *retry-times*
Restore the maximum number of retries for real-time accounting requests to the default value.	**undo retry realtime-accounting**

The value of *retry-times* is the ceiling value of T/t, where *T* is the period of time in which the RADIUS server connection will timeout, and *t* is the real-time accounting interval of NAS.

By default, the value for *retry-times* is 5.

Enabling/Disabling Stop Accounting Request Buffer

Because the stop accounting request concerns the account balance, and affects the amount to charge a customer, NAS makes its best effort to send the message to the RADIUS accounting server. If the message from the Switch 8800 to RADIUS accounting server has not been responded to, the switch saves it in the local buffer and retransmits until the server responds or discards the messages. The following command can be used to enable the storage of the stop accounting message. If the stop-accounting buffer is enabled, make sure you set the maximum retransmission time.

Perform the following configurations in RADIUS server group view.

Table 28 Enable/Disable Stopping Accounting Request Buffer

Operation	Command
Enable the stop accounting request buffer	**stop-accounting-buffer enable**
Disable the stop accounting request buffer	**undo stop-accounting-buffer enable**

By default, the stop accounting request will be saved in the buffer.

Setting the Maximum Retransmitting Times of the Stop Accounting Request

Because the stop accounting request concerns account balance, and will affect the amount to charge a customer, which is very important for both the subscribers and the ISP, NAS will make its best effort to send the message to the RADIUS accounting server. If the message from the Switch 8800 to RADIUS accounting server has not replied, the switch saves it in the local buffer and retransmits it until

the server responds or discards the messages. Use this command to set the maximum retransmission times.

Perform the following configurations in RADIUS server group view.

Table 29 Set the Maximum Retransmitting Times of Stopping Accounting Request

Operation	Command
Set the maximum retransmitting times of stop accounting request	**retry stop-accounting** *retry-times*
Restore the maximum retransmitting times of stop accounting request to the default value	**undo retry stop-accounting**

By default, the stop accounting request can be retransmitted for up to 500 times.

Setting the Supported Type of RADIUS Server

The Switch 8800 supports the standard RADIUS protocol and the extended RADIUS service platforms, such as IP Hotel, and Portal.

Perform the following configurations in RADIUS server group view.

Table 30 Setting the Supported Type of RADIUS Server

Operation	Command
Setting the supported type of RADIUS Server	**server-type** {**3ComType	iphotel	portal	standard**}
Restore the supported type of RADIUS Server to the default setting	**undo server-type**

By default, the RADIUS server type is **standard**.

Setting RADIUS Server State

For the primary and secondary servers, if the primary server is disconnected from NAS because of a fault, NAS will automatically turn to exchange packets with the secondary server. However, after the primary server recovers, NAS does not resume communication with the primary server immediately, instead, it continues communicating with the secondary server. When the secondary server fails to communicate, NAS returns to the primary server. The following commands can be used to set the primary server to be **active** manually, so that NAS can communicate with it immediately after troubleshooting.

When the primary and second servers are both **active** or **block**, NAS sends the packets to the primary server only.

Perform the following configurations in RADIUS server group view.

Table 31 Set RADIUS Server State

Operation	Command
Set the state of primary RADIUS server	**state primary** {**accounting	authentication**} {**block	active**}
Set the state of second RADIUS server	**state secondary**{**accounting	authentication**} {**block	active**}

By default, the state of each server in RADIUS server group is **active**.

Setting Username Format Transmitted to RADIUS Server

As mentioned before, clients are generally named in userid@isp-name format. The part following "@" is the ISP domain name. The Switch 8800 will put users into different ISP domains according to their domain name. However, some earlier RADIUS servers rejected the username including ISP domain name. In this case, you have to remove the domain name before sending the username to the RADIUS server. The following command of switch decides whether the username to be sent to RADIUS server carries ISP domain name or not.

Table 32 Set Username Format Transmitted to RADIUS Server

Operation	Command
Set username format transmitted to the RADIUS Server	**user-name-format** {**with-domain** | **without-domain**}

If a RADIUS server group is configured not to allow usernames including ISP domain names, the RADIUS server group cannot be simultaneously used in more than one ISP domain. Otherwise, the RADIUS server will regard two users in different ISP domains as the same user by mistake, if they have the same username (excluding their respective domain names.)

By default, the RADIUS server group acknowledges that the username sent to it includes ISP domain name.

Setting the Unit of Data Flow that Transmitted to RADIUS Server

The following command defines the unit of the data flow sent to RADIUS server.

Table 33 Set the Unit of Data Flow Transmitted to RADIUS Server

Operation	Command
Set the unit of data flow transmitted to RADIUS server	**data-flow-format data** { **byte** | **giga-byte** | **kilo-byte** | **mega-byte** } **packet** { **giga-byte** | **kilo-byte** | **mega-byte** | **one-packet** }

By default, the default data unit is a byte and the default data packet unit is one packet.

Configuring a Local RADIUS Server Group

RADIUS service adopts authentication/authorization servers to manage users. Local authentication/authorization/accounting service is also used in these products and it is called local RADIUS function.

Perform the following commands in system view to create/delete local RADIUS server group.

Table 34 Create/Delete a Local RADIUS Server Group

Operation	Command
Create a local RADIUS server group and enter its view	**local-server nas-ip** *ip-address* **key** *password*
Delete a local RADIUS server group	**undo local-server nas-ip** *ip-address*

By default, the IP address of local RADIUS server group is 127.0.0.1 and the password is 3com.

When using the local RADIUS server function of the Switch 8800, remember that:

- The number of the UDP port used for authentication is 1645 and the number for accounting is 1646.
- The password configured by local-server command must be the same as that of the RADIUS authentication/authorization packet configured by the command key authentication in the Radius server group view

Displaying and Debugging the AAA and RADIUS Protocols

After you configure RADIUS, execute the **display** command in all views to display the operation of the AAA and RADIUS configuration, and to verify the effect of the configuration. Execute the **reset** command in user view to reset AAA and RADIUS configuration. Execute the **debugging** command in user view to debug AAA and RADIUS.

Table 35 Display and Debug AAA and RADIUS Protocol

Operation	Command
Display the configuration information of the specified or all the ISP domains.	**display domain** [*isp-name*]
Display related information of user's connection	**display connection** {**access-type** {**dot1x	gcm}	domain** *isp-name*	**interface** *portnum*	**ip** *ip-address*	**mac** *mac-address*	**radius-scheme** *radius-scheme-name*	**vlan** *vlanid*	**ucibindex** *ucib-index*	**user-name** *user-name*}
Display related information of the local user	**display local-user** [**domain** *isp-name*	**idle-cut** {**disable	enable}	service-type {telnet	ftp	lan-access** }	**state** {**active	block**}	**user-name** *user-name*	**vlan** *vlan-id*]
Display information of local RADIUS server group	**display local-server statistics**
Display the configuration information of all the RADIUS server groups or a specified one	**display radius** [*radius-server-name*]
Display the statistics information of RADIUS packets	**display radius statistics**
Reset the statistics of the Radius server	**reset radius statistics**
Display the stopping accounting requests saved in buffer without response (from system view)	**display stop-accounting-buffer** {**radius-scheme** *radius-scheme-name*	**session-id** *session-id*	**time-range** *start-time stop-time*	**user-name** *user-name*}
Delete the stopping accounting requests saved in buffer without response (from system view)	**reset stop-accounting-buffer** {**radius-scheme** *radius-scheme-name*	**session-id** *session-id*	**time-range** *start-time stop-time*	**user-name** *user-name***}**

Example: AAA and RADIUS Protocol Configuration

AAA/RADIUS protocol configuration commands are generally used together with 802.1x configuration commands. Refer to the typical configuration examples provided in "Configuring 802.1x" on page 267.

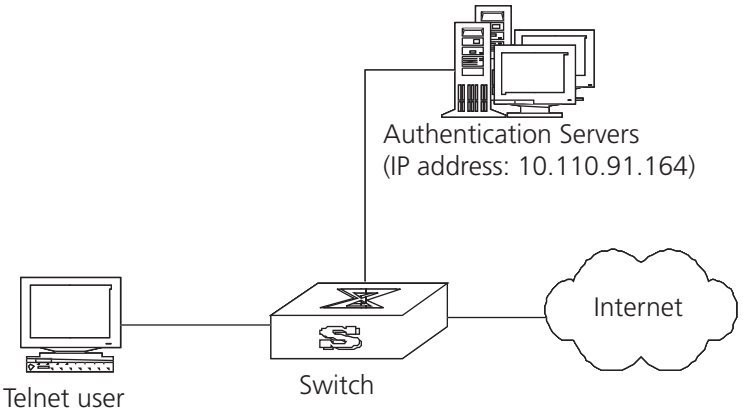
Configuring FTP/Telnet User Authentication at Remote RADIUS Server

Configuring Telnet user authentication at the remote server is similar to configuring FTP users. The following description is based on Telnet users.

In the environment illustrated in the following figure, it is required to achieve through proper configuration that the RADIUS server authenticates the Telnet users to be registered.

One RADIUS server (as authentication server) is connected to the switch and the server IP address is 10.110.91.146. The password for exchanging messages between the switch and the authentication server is "expert". The switch cuts off domain name from username and sends the left part to the RADIUS server.

Figure 4 Configuring Remote RADIUS Authentication for Telnet Users



1 Add a Telnet user.

For details about configuring FTP and Telnet users, see "Configuring the User Interface" on page 11.

2 Configure the remote authentication mode for the Telnet user, in this example, the scheme mode.

```
[SW8800-ui-vty0-4]authentication-mode scheme
```

3 Configure the domain.

```
[SW8800]domain cams
[SW8800-isp-cams]quit
```

4 Configure RADIUS scheme.

```
[SW8800]radius scheme cams
[SW8800-radius-cams]primary authentication 10.110.91.146 1812
[SW8800-radius-cams]key authentication expert
[SW8800-radius-cams]server-type 3com
[SW8800-radius-cams]user-name-format without-domain
```

5 Configure the association between domain and RADIUS.

```
[SW8800-radius-cams]quit
[SW8800]domain cams
[SW8800-isp-cams]radius-scheme cams
```

Configuring FTP/Telnet User Authentication at the Local RADIUS Server

Local RADIUS authentication of Telnet/FTP users is similar to remote RADIUS authentication. But you should modify the server IP address to 127.0.0.1, authentication password to 3Com, the UDP port number of the authentication server to 1645.

For details about local RADIUS authentication of Telnet/FTP users, see "Configuring a Local RADIUS Server Group"on page 286.

Troubleshooting AAA and RADIUS

The RADIUS protocol of TCP/IP protocol suite is located on the application layer. It basically specifies how to exchange user information between NAS and RADIUS server of ISP. So it is likely to be invalid.

Tasks for Troubleshooting AAA and Radius are described in the following sections:

- User authentication/authorization always fails
- RADIUS packet cannot be transmitted to RADIUS server.
- After being authenticated and authorized, the user cannot send charging bill to the RADIUS server.

User authentication/authorization always fails

1. The username may not be in the userid@isp-name format or NAS has not been configured with a default ISP domain. Please use the username in proper format and configure the default ISP domain on NAS.
2. The user may not have been configured in the RADIUS server database. Check the database and make sure that the configuration information of the user does exist in the database.
3. The user may have input a wrong password. Make sure that the supplicant inputs the correct password.
4. The encryption keys of RADIUS server and NAS may be different. Check carefully and make sure that they are identical.
5. There might be some communication fault between NAS and RADIUS server, which can be discovered through pinging RADIUS from NAS. Ensure the normal communication between NAS and RADIUS.

RADIUS packet cannot be transmitted to RADIUS server.

1. The communication lines (on physical layer or link layer) connecting NAS and RADIUS server may not work well.
2. The IP address of the corresponding RADIUS server may not have been set on NAS. Set a proper IP address for RADIUS server.
3. UDP ports of authentication/authorization and accounting services may not be set properly. Make sure they are consistent with the ports provided by RADIUS server.

After being authenticated and authorized, the user cannot send charging bill to the RADIUS server.

1. The accounting port number may be set improperly. Set a proper number.
2. The accounting service and authentication/authorization service are provided on different servers, but NAS requires the services to be provided on one server (by specifying the same IP address). Make sure the settings of servers are consistent with the actual conditions.

10 RELIABILITY

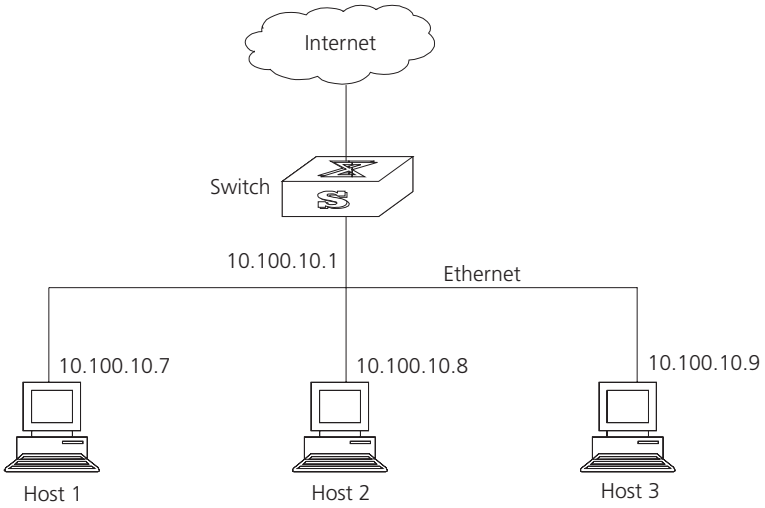
This chapter covers the following topics:

- VRRP Overview
- Configuring VRRP

VRRP Overview

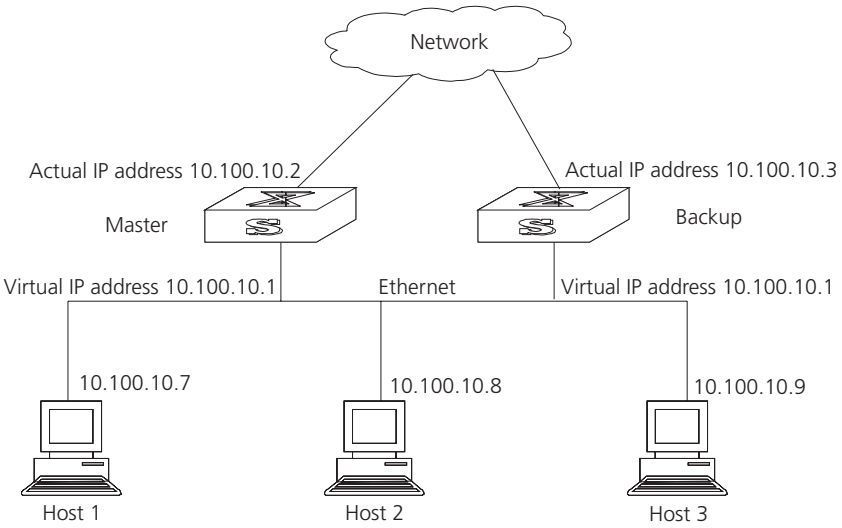
Virtual Router Redundancy Protocol (VRRP) is a fault-tolerant protocol. In general, a default route, for example, 10.100.10.1 in Figure 1, is configured for every host on a network, so that packets destined for another network segment go through the default route to Layer 3 Switch1, implementing communication between the host and the external network. If Switch1 is down, all the hosts on this segment have Switch1 as the next-hop for the default route and are disconnected from the external network.

Figure 1 LAN Networking



VRRP, which is designed for LANs with multicast and broadcast capabilities (such as Ethernet) settles this problem. Figure 2 illustrates the implementation principal of VRRP. VRRP combines a group of LAN switches, including a master and several backups, into a virtual router, or backup group.

Figure 2 Virtual Router



This virtual router has its own IP address: 10.100.10.1, which can be the actual interface address of a switch within the virtual router. The switches within the virtual router have their own IP addresses, such as 10.100.10.2 for the Master switch and 10.100.10.3 for the BACKUP switch. The hosts on the LAN use the IP address of this virtual router 10.100.10.1, but not the specific IP addresses 10.100.10.2 of the master switch and 10.100.10.3 of the backup switch. The default routes for the hosts on this LAN are configured using the IP address of this virtual router 10.100.10.1 as their gateway. Therefore, hosts within the network communicate with the external network through this virtual router. If a master switch in the virtual router group breaks down, the backup switch functions as the new master switch. This avoids interrupting communication between the hosts and external networks.

Configuring VRRP

VRRP configuration tasks are described in the following sections:

- Enable Pinging the Virtual IP Address
- Setting Correspondence Between Virtual IP and MAC Addresses
- Adding and Deleting a Virtual IP Address
- Configuring the Priority of Switches
- Configuring Preemption and Delay for a Switch
- Configuring Authentication Type and Authentication Key
- Configuring the VRRP Timer
- Configuring a Switch to Track an Interface

Enable Pinging the Virtual IP Address

This operation enables or disables ping response for the virtual IP address of the backup group. The standard VRRP protocol does not support ping response.

Perform the following commands in system view.

Table 1 Enable/Disable the Ping Function

Operation	Command
Enable pinging of the virtual IP address	**vrrp ping-enable**
Disable pinging of the virtual IP address	**undo vrrp ping-enable**

By default, ping response for the virtual IP address is disabled.

Setting Correspondence Between Virtual IP and MAC Addresses

This operation sets the virtual IP address to correspond to either the real or the virtual MAC address. In the standard VRRP protocol, the virtual IP address of the backup group corresponds to the virtual MAC address, and guarantees correct data forwarding in the sub-net.

The Switch 8800 switches support matching the virtual IP address with either the real MAC address or the virtual MAC address of the routing interface.

The following command can be used to establish a relationship between the IP address and the MAC address.

Perform the following configuration in system view.

Table 2 Set the Correspondence Between Virtual IP and MAC Addresses

Operation	Command
Set correspondence between the virtual IP address and the MAC address	**vrrp method** { **real-mac** | **virtual-mac** }
Set the correspondence to the default value	**undo vrrp method**

By default, the virtual IP address of the backup group corresponds to the virtual MAC address.

You should set correspondence between the virtual IP address of the backup group and the MAC address before configuring the backup group; other wise, you cannot configure the correspondence.

Adding and Deleting a Virtual IP Address

The virtual-router-ID covers the range from 1 to 255. The virtual-address can be an unused address in the network segment where the virtual router resides, or the IP address of an interface in the virtual router. If the IP address is on the switch, the switch is called an IP address owner. When adding the first IP address to a virtual router, the system creates a new virtual router instance. When adding new addresses to this backup group thereafter, the system adds it directly to the virtual IP address list.

After the last virtual IP address is removed from the virtual router, the whole virtual router is removed.

The following command is used for assigning an IP address from the local segment to a virtual router, or removing an assigned virtual IP address of a virtual router from the virtual address list.

Perform the following configuration in VLAN interface view.

Table 3 Add/Delete a Virtual IP Address

Operation	Command
Add a virtual IP address.	**vrrp vrid** *virtual-router-ID* **virtual-ip** *virtual-address*
Delete a virtual IP address.	**undo vrrp vrid** *virtual-router-ID* [**virtual-ip** *virtual-address*]

Configuring the Priority of Switches

The status of each switch in the virtual router group is determined by its priority in VRRP. The switch with the highest priority becomes the master.

The priority ranges from 0 to 255 (the greater the number, the higher the priority. However only values from 1 to 254 can be used. Priority 0 is reserved for special use and 255 is reserved for the IP address owner.

Perform the following configuration in VLAN interface view.

Table 4 Configure the Priority of Switches in the Virtual Router

Operation	Command
Configure the priority of switches in the virtual router.	**vrrp vrid** *virtual-router-ID* **priority** priority
Clear the priority of switches in the virtual router.	**undo vrrp vrid** *virtual-router-ID* **priority**

By default, the priority is 100.

The priority for an IP address owner is always 255, which cannot be changed.

Configuring Preemption and Delay for a Switch

When a switch in the virtual router functions as a master switch, other switches, even if they are configured with a higher priority later, cannot become the master switch unless they are configured to work in preemption mode. The switch in preemption mode can become the master switch when it finds that its own priority is higher than the priority of the current master switch. If this happens, the former master switch becomes the backup switch.

In addition to preemption settings, a delay can also be set. A backup switch waits for a period of time before becoming a master. In an unstable network, if the backup switch has not received packets from the master switch periodically, it becomes the master switch. However, the failure of the backup switch to receive packets may be due to network congestion instead of the malfunction of the master switch. In this case, the backup switch receives the packets after a while. The delay settings can thereby avoid a frequent change of status.

Perform the following configuration in VLAN interface view.

Table 5 Configure Preemption and Delay for a Switch

Operation	Command
Enable the preemption mode and configure a period of delay.	**vrrp vrid** *virtual-router-ID* **preempt-mode** [**timer delay** *delay-value*]
Disable the preemption mode.	**undo vrrp vrid** *virtual-router-ID* **preempt-mode**

The delay ranges from 0 to 255, measured in seconds. The default mode is preemption with a delay of 0 second.

Configuring Authentication Type and Authentication Key

To prevent unauthorized routes from joining the virtual router, a key can be configured that is used in one of the following VRRP authentication types:

- Simple character authentication — The authentication type is set to **simple**. The switch adds the authentication key to the VRRP packets before transmitting it. The receiver compares the authentication key of the packet to the locally configured authentication key. If they are the same, the packet is accepted as a true and legal. If the keys are not the same the packet is considered illegal and is discarded. A simple authentication key should not exceed 8 characters.
- MD5 authentication — The authentication type is set to **md5**. The switch uses the authentication type and MD5 algorithm, provided by the authentication, header to authenticate VRRP packets. An md5 authentication key should not exceed 16 packets that fail to pass the authentication test. If 16 fail they are discarded and a trap packet is sent to the network management system.

Perform the following configuration in VLAN interface view.

Table 6 Configure Authentication Type and Authentication Key

Operation	Command
Configure the authentication type and authentication key.	**vrrp authentication-mode** *type* [*key*]
Clear the authentication type and authentication key.	**undo vrrp authentication-mode**

The same authentication type and authentication key should be configured for all vlan interfaces that belong to the virtual router.

Configuring the VRRP Timer

The Master switch advertises its normal operation state to the switches within the VRRP virtual router by sending them VRRP packets regularly, at the specified advertised interval. If the backup switch does not receive a VRRP packet from the master after a period of time (specified by master-down-interval), the master is assumed to have failed and the backup switch takes the role of master.

You can use the following command to set a timer and adjust the interval, *adver-interval* at which the master transmits VRRP packets. The duration of the backup switch's *master-down-interval* is three times the duration of the *adver-interval*. Excessive network traffic or the differences between different switch timers results in *master-down-interval* timing out and state changing abnormally. Such problems can be solved through prolonging the *adver-interval* and setting delay time. The duration of *adver-interval* is measured in seconds.

Perform the following configuration in VLAN interface view.

Table 7 Configure VRRP Timer

Operation	Command
Configure VRRP timer	**vrrp vrid** *virtual-router-ID* **timer advertise** *adver-interval*

Table 7 Configure VRRP Timer

Operation	Command
Clear VRRP timer	**undo vrrp vrid** *virtual-router-ID* **timer advertise**

By default, *adver-interval* is 1.

Configuring a Switch to Track an Interface

The VRRP track interface function expands the backup function by including other switch interfaces of participating routers. Backup is provided not only to the interface where the virtual router resides, but also to other switch interfaces of participating routers. By implementing the following command you can track interfaces. If the interface that is being tracked fails, the priority of the switch, including the interface, decreases automatically by the value specified by *value-reduced*. The reduced priority of the switch results in comparatively higher priorities of other switches within the virtual router, one of which becomes the master switch.

Perform the following configuration in VLAN interface view.

Table 8 Configure Switch to Track a Specified Interface

Operation	Command
Configure to track a specified interface	**vrrp vrid** *virtual-router-ID* **track vlan-interface** *interface-num* [**reduced** *value-reduced*]
Stop tracking the specified interface	**undo vrrp vrid** *virtual-router-ID* **track** [**vlan-interface** *interface-num*]

By default, *value-reduced* is set at 10.

When the switch is an IP address owner, its interfaces cannot be tracked.

Displaying and Debugging VRRP

After you configure a virtual router, execute the **display** command in all views to display the VRRP configuration, and to verify the effect of the VRRP configuration.

Table 9 Display and Debug VRRP

Operation	Command
Display VRRP state information.	**display vrrp** [**interface vlan-interface** *interface-num*] [*virtual-router-ID*]
Enable VRRP debugging.	**debugging vrrp** { **state | packet** }
Clear VRRP statistics	**reset vrrp statistics** [**vlan-interface** *interface-num* [*virtual-router-ID*]]
Disable VRRP debugging.	**undo debugging vrrp** { **state** | **packet** }

You can enable VRRP debugging to display how it runs. You can set the argument option to **packet** or **state** to debug the VRRP packet or VRRP state.

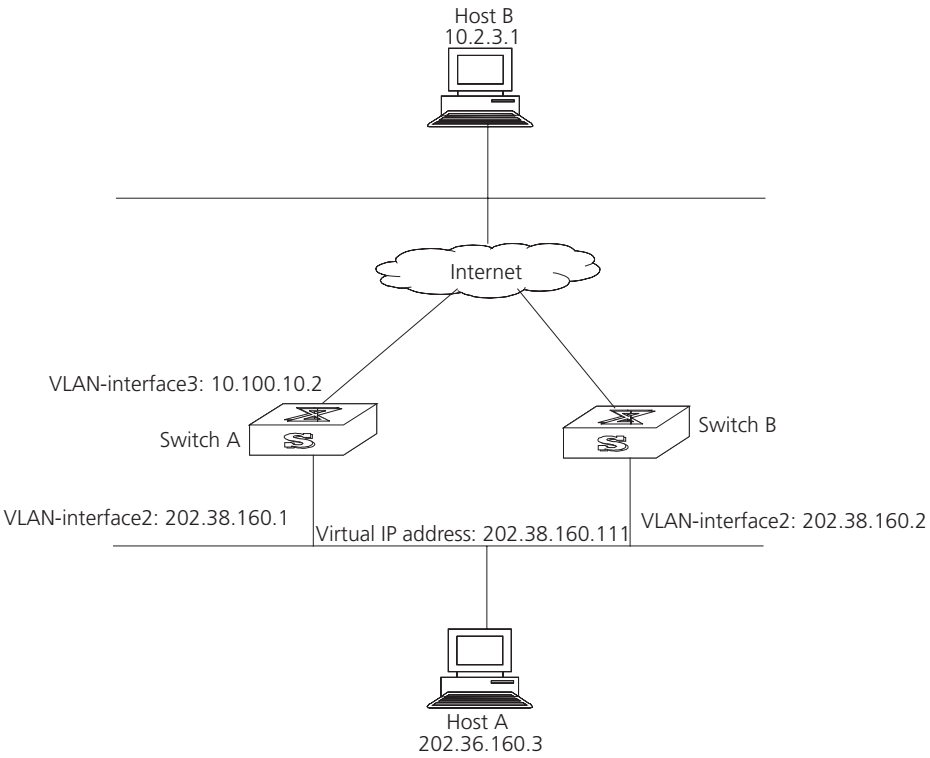
By default, the switch disables debugging.

Example: VRRP Single Virtual Router

Host A uses the VRRP virtual router which combines switch A and switch B as its default gateway to visit host B on the Internet.

VRRP virtual router information includes virtual router ID1, virtual IP address 202.38.160.111, switch A as the Master and switch B as the backup allowed preemption.

Figure 3 VRRP Configuration



Configure switch A:

```
[SW8800_A-vlan-interface2]vrrp vrid 1 virtual-ip 202.38.160.111
[SW8800_A-vlan-interface2]vrrp vrid 1 priority 110
```

Configure switch B:

```
[SW8800_B-vlan-interface2]vrrp vrid 1 virtual-ip 202.38.160.111
```

The virtual router can be used after all routers in the group are configured. The host A default gateway should be configured as 202.38.160.111.

Under normal conditions, switch A functions as the gateway, but when switch A is turned off or is malfunctioning, switch B functions as the gateway instead.

Example: VRRP Tracking Interface

Even when switch A is still functioning, it may want Switch B to function as a gateway if a critical interface connected with it does not function properly. This can be implemented by configuring a tracking interface. The virtual router ID is set to 1 with additional configurations of an authorization key and timer.

Configure switch A

1 Create a virtual router.

```
[SW8800_A-vlan-interface2]vrrp vrid 1 virtual-ip 202.38.160.111
```

2 Set the priority for the virtual router.

```
[SW8800_A-vlan-interface2]vrrp vrid 1 priority 110
```

3 Set the authentication key for the virtual router.

```
[SW8800_A-vlan-interface2]vrrp authentication-mode md5 lanswitch
```

4 Set Master to send VRRP packets every 5 seconds.

```
[SW8800_A-vlan-interface2]vrrp vrid 1 timer advertise 5
```

5 Track an interface.

```
[SW8800_A-vlan-interface2]vrrp vrid 1 track vlan-interface 3 reduced
30
```

Configure switch B

1 Create a virtual router.

```
[SW8800_B-vlan-interface2]vrrp vrid 1 virtual-ip 202.38.160.111
```

2 Set the authentication key for the virtual router.

```
[SW8800_B-vlan-interface2]vrrp authentication-mode md5 lanswitch
```

3 Set Master to send VRRP packets every 5 seconds.

```
[SW8800_B-vlan-interface2]vrrp vrid 1 timer advertise 5
```

Under normal conditions, switch A functions as the gateway. When the interface vlan-interface 3 of switch A is down, its priority is reduced by 30, so run priority is 80. This run priority value is lower than the run priority value of switch B so switch B preempts the master for gateway services.

When vlan-interface3, the switch A interface, recovers, this switch resumes its gateway function as master.

Example: Multiple Virtual Routers

A Switch can function as the backup switch for many virtual routers.

Such a multi-backup configuration can implement load balancing. For example, switch A, as master switch of group 1, can share the responsibility of the backup switch for virtual router 2, and switch B performs the same functions for group 2 and virtual router 1. Some hosts employ virtual router 1 as the gateway, while others employ virtual router 2 as the gateway. In this way, both load balancing and mutual backup are possible.

Load balancing is not supported in virtual-mac mode.

Configure switch A:

1 Create virtual router 1.

```
[SW8800_A-vlan-interface2]vrrp vrid 1 virtual-ip 202.38.160.111
```

2 Set the priority for the virtual router.

```
[SW8800_A-vlan-interface2]vrrp vrid 1 priority 150
```

3 Create virtual router 2.

```
[SW8800_A-vlan-interface2]vrrp vrid 2 virtual-ip 202.38.160.112
```

Configure switch B:

1 Create virtual router 1.

```
[SW8800_B-vlan-interface2]vrrp vrid 1 virtual-ip 202.38.160.111
```

2 Create virtual router 2.

```
[SW8800_B-vlan-interface2]vrrp vrid 2 virtual-ip 202.38.160.112
```

3 Set the priority for the virtual router.

```
[SW8800_B-vlan-interface2]vrrp vrid 2 priority 110
```

Troubleshooting VRRP

The configuration of VRRP is simple so almost all troubleshooting can be done by viewing the configuration and debugging information. Here are some possible failures you might experience and the corresponding troubleshooting methods.

Tasks for Troubleshooting VRRP are described in the following sections:

- Frequent Prompts of Configuration Errors on the Console
- More than One Master Exists Within the Same Virtual Router
- Frequent Switchover of VRRP State

Frequent Prompts of Configuration Errors on the Console

This indicates that an incorrect VRRP packet has been received. It may be because of the inconsistent configuration of another switch within the virtual router, or the attempt of some devices to send out illegal VRRP packets.

The first possible fault can be solved by modifying the configuration. Because the second possibility is caused by the malicious attempt of some devices, you should resort to non-technical measures.

More than One Master Exists Within the Same Virtual Router

One possible reason for this situation is the short-time coexistence of many master switches; which is normal and needs no manual intervention.

Another possible reason is the coexistence of many master switches over a long period of time, because several masters cannot receive VRRP packets from each other, or because they have received illegal packets.

To solve this problem, ping the Master switches. If pinging fails, there are other problems. If the masters can be pinged, it indicates that the problems are caused by an inconsistent configuration. For the configuration of the same VRRP virtual router, the number of virtual IP addresses, each virtual IP address, timer duration, and authentication type, must be consistent.

Frequent Switchover of VRRP State

This problem occurs when the virtual router timer duration is set too short.

Increase the duration of the timer or configure a preemption delay.

11 SYSTEM MANAGEMENT

This chapter covers the following topics:

- File System
- Managing the MAC Address Table
- Managing Devices
- Maintaining and Debugging the System
- SNMP
- RMON
- NTP

File System

The Switch 8800 provides a file system module for efficient management with storage devices such as flash memory. The file system offers file access and directory management, including creating the file system; creating, deleting, modifying, and renaming a file or a directory; and opening files.

By default, the file system requires that the user confirm before executing commands. This prevents unwanted data loss.

Managing the file system is described in the following sections:

- Using a Directory
- Managing Files
- Formatting Storage Devices
- Setting the Prompt Mode of the File System
- Configuring File Management
- FTP
- TFTP

Using a Directory

You can use the file system to create or delete a directory, display the current working directory, and display the information about the files or directories under a specified directory. Use the commands in Table 1 to perform directory operations.

Perform the following operations in user view.

Table 1 Directory Operation

Operation	Command
Create a directory	**mkdir** *directory*

Table 1 Directory Operation

Operation	Command
Delete a directory	**rmdir** *directory*
Display the current working directory	**pwd**
Display the information about directories or files	**dir** [/ **all**] [*file-url*]
Change the current directory	**cd** *directory*

Managing Files

You can use the file system to delete, undelete, or permanently delete a file. It can also be used to display file contents; rename, copy, and move a file; and display the information about a specified file. Use the commands in Table 2 to perform file operations.

Perform the following operations in user view.

Table 2 File Operation

Operation	Command
Delete a file from the file system and move it to the recycle bin	**delete** *file-url*
Restore a file from the recycle bin	**undelete** *file-url*
Delete a file from the recycle bin permanently	**reset recycle-bin** *file-url*
View contents of a file	**more** *file-url*
Rename a file	**rename** *fileurl-source fileurl-dest*
Copy a file	**copy** *fileurl-source fileurl-dest*
Move a file	**move** *fileurl-source fileurl-dest*
Display the information about directories or files	**dir** [/ **all**] [*file-url*]
Execute a batch file (system view)	**execute** *filename*

Formatting Storage Devices

The file system can be used to format the flash memory on the Switch 8800 fabric module.

Perform the following operation in user view.

Table 3 Formatting Storage Devices

Operation	Command
Format the storage device	**format** *filesystem*

Setting the Prompt Mode of the File System

Use the command in Table 4 to confirm prompts for file system commands.

Perform the following operation in system view.

Table 4 File System Operation

Operation	Command
Set the file system prompt mode.	**file prompt** { **alert** | **quiet** }

Example: File System Operation

1 Format the flash.

```
<SW8800>format flash:
All sectors will be erased, proceed? [confirm] y
Format flash: completed
```

2 Display the working directory in the flash.

```
<SW8800>cd flash:/
<SW8800>pwd
flash:/
```

3 Create a directory named test.

```
<SW8800>mkdir test
```

4 Display the flash directory information after creating the test directory.

```
<SW8800>dir
Directory of flash:/

   0   -rw-   6703685  Nov 12 2004 16:01:53   88003-00.app
   1   drw-         -  Nov 12 2004 16:04:26   hafile
   2   -rw-         4  Dec 03 2004 04:46:36   snmpboots
   3   -rw-      1823  Dec 03 2004 04:45:02   sw8800.cfg
   4   -rw-   6326532  Dec 03 2004 04:44:04   88003-00ec06.app

15621 KB total (2836 KB free)
```

Configuring File Management

The configuration file includes commands based on command views. The commands are sorted in one section and sections are separated with a blank line or a comment line (A comment line begins with a pound sign "# "). Default constants are not saved.

Generally, the sections in the file are arranged in the following order: system configuration, ethernet port configuration, vlan interface configuration, routing protocol configuration, and so on.

Management of the configuration files includes tasks described in the following sections:

- Displaying the Current and Saved Configuration of the Switch
- Saving the Current Configuration
- Erasing the Configuration Files from Flash Memory

Displaying the Current and Saved Configuration of the Switch

After being powered on, the system reads the configuration file from flash memory. The default configuration file is `sw8800.cfg`. If there is no configuration file in flash, the system begins the initialization with the default parameters. You can use the commands in Table 5 to display the current and saved configuration of the switch.

Perform the following configuration in all views.

Table 5 Display the Configurations of the Switch

Operation	Command
Display the saved configuration of the Ethernet switch	**display saved-configuration**
Display the current configuration of the Ethernet switch	**display current-configuration** [**controller | interface** *interface-type* [*interface-number*] | **configuration** [*configuration*] [| { begin | exclude | **include** } *regular-expression*]

The configuration files are displayed in their corresponding saving formats.

Saving the Current Configuration

Use the **save** command to retain the current-configuration in the flash memory. The configurations are saved when the system is powered on for the next time.

Perform the following configuration in user view.

Table 6 Save the Current-Configuration

Operation	Command
Save the current-configuration	**save**

Erasing the Configuration Files from Flash Memory

The **reset saved-configuration** command can be used to erase the configuration files from flash memory. The system will use the default configuration parameters for initialization when the switch is powered on the next time.

Perform the following configuration in user view.

Table 7 Erase the Configuration Files from Flash Memory

Operation	Command
Erase the configuration files from the Flash Memory	**reset saved-configuration**

You can erase the configuration files from flash memory in the following cases:

- If the software does not match the configuration files after the software is upgraded.
- If the configuration files in flash are damaged, for example, if the wrong configuration file has been downloaded.)

FTP FTP is a common way to transmit files on the Internet and IP network. FTP is a TCP/IP protocol on the application layer and is used for transmitting files between a remote server and a local host.

The Ethernet switch provides the following FTP services:

- FTP server — You can run the FTP client program to log in to the server and access the files on it.
- FTP client — After connecting to the server by running the terminal emulator or Telnet on a PC, you can access the files on it, using the FTP command.

FTP Server configuration includes tasks described in the following sections:

- Enabling and Disabling the FTP Server
- Configuring the FTP Server Authentication and Authorization
- Configuring FTP Server Parameters
- Displaying and Debugging the FTP Server

Enabling and Disabling the FTP Server

You can use the following commands to enable or disable the FTP server. Perform the following configuration in system view.

Table 8 Enable/Disable FTP Server

Operation	Command
Enable the FTP server	**ftp server enable**
Disable the FTP server	**undo ftp server**

The FTP server supports multiple user access. A remote FTP client sends a request to the FTP server. Then, the FTP server carries out the corresponding operation and returns the result to the client.

By default, the FTP server is disabled.

Configuring the FTP Server Authentication and Authorization

You can use the following commands to configure FTP server authentication and authorization. The authorization information of the FTP server includes the top working directory provided for FTP clients.

Perform the following configuration in system view.

Table 9 Configure the FTP Server Authentication and Authorization

Operation	Command
Create new local user and enter local user view (system view)	**local-user** *username*
Delete local user (system view)	**undo local-user** [*username* | **all** [**service-type ftp**]]
Configure password for local user (local user view)	**password** [**cipher** | **simple**] *password*
Configure service type for local user (local user view)	**service-type ftp ftp-directory** *directory*
Cancel password for local user (local user view)	**undo password**
Cancel service type for local user (local user view)	**undo service-type ftp** [**ftp-directory**]

Only clients who have passed the authentication and authorization successfully can access the FTP server.

Configuring FTP Server Parameters

You can use the following commands to configure the connection timeout of the FTP server. If the FTP server does not receive a service request from the FTP client

for a period of time, it will cut the connection to it, thereby avoiding illegal access by unauthorized users.

Perform the following configuration in system view.

Table 10 Configure FTP Server Connection Timeout

Operation	Command
Configure FTP server connection timeouts	**ftp timeout** *minute*
Restoring the default FTP server connection timeouts	**undo ftp timeout**

By default, the FTP server connection timeout is 30 minutes.

Displaying and Debugging the FTP Server

Execute the **display** command in all views to display the FTP Server configuration, and to verify the effect of the configuration.

Table 11 Display and Debug the FTP Server

Operation	Command
Display FTP server	**display ftp-server**
Display the connected FTP users.	**display ftp-user**

The **display ftp-server** command can be used for displaying configuration information about the current FTP server, including, the maximum amount of users supported by FTP server and the FTP connection timeout. The **display ftp-user** command can be used for displaying the detail information about connected FTP users.

TFTP Trivial File Transfer Protocol (TFTP) is a simple protocol for file transmission that has no complicated interactive access interface or authentication control, and therefore it can be used when there is no complicated interaction between the clients and server.

TFTP transmission originates with the client. To download a file, the client sends a request to the TFTP server and receives the data, then sends an acknowledgement to it. To upload a file, the client sends a request to the TFTP server and transmits data to it, then receives the acknowledgement from it.

TFTP configuration tasks include:

- Configuring the File Transmission Mode
- Downloading Files with TFTP
- Downloading Files with TFTP

Configuring the File Transmission Mode

TFTP transmits files in two modes; binary mode for program files and ASCII mode for text files. Use the following commands to configure the file transmission mode.

Perform the following configuration in system view.

Table 12 Configuring the File Transmission Mode

Operation	Command
Configure the file transmission mode	**tftp** { **ascii | binary** }

By default, TFTP transmits files in binary mode.

Downloading Files with TFTP

To download a file, the client sends a request to the TFTP server and receives data from it, then sends acknowledgement to it. Use the following commands to download files with TFTP.

Perform the following configuration in system view.

Table 13 Downloading Files with TFTP

Operation	Command
Download files with TFTP	**tftp** *tftp-server* **get** *source-file [dest-file]*

Uploading Files with TFTP

To upload a file, the client sends a request to the TFTP server and transmits data to it, then receives the acknowledgement from it. Use the following commands to upload files.

Perform the following configuration in system view.

Table 14 Uploading Files with TFTP

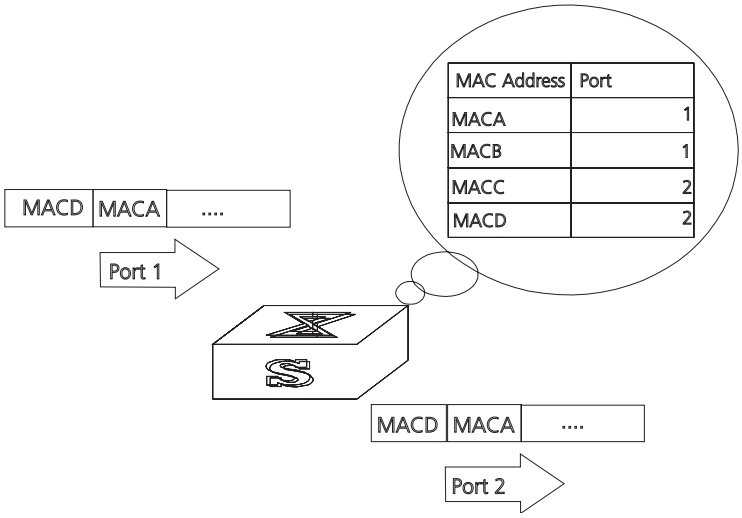
Operation	Command
Upload files with TFTP	**tftp** *tftp-server* **put** *source-file [dest-file]*

Managing the MAC Address Table

The Switch 8800 maintains a MAC address table for fast forwarding of packets. A table entry includes the MAC address of a device and the port ID of the switch connected to it. The switch learns dynamic entries when it receives a data frame from a port (assumed as port A). The switch analyzes the source MAC address and considers that the packets destined for the source MAC address can be forwarded through port A. If the MAC address table contains the MAC_SOURCE, the switch updates the corresponding entry, otherwise, it adds the new MAC address (and the corresponding forwarding port) as a new entry to the table.

The system forwards the packets whose destination addresses can be found in the MAC address table. The network device responds after receiving a broadcast packet and the response contains the MAC address of the device, which the switch learns and adds in the MAC address table. After this, subsequent packets destined for the same MAC address can be forwarded directly.

Figure 1 The Switch 8800 Forwards Packets According to the MAC Address Table



The Switch 8800 also provides the function of MAC address aging. If the switch does not receive a packet from a MAC address for a set period of time, it will delete the related entry from the MAC address table.

You can add or modify MAC address entries manually according to the actual networking environment. The entries can be static or dynamic. The default aging time is five minutes.

Configuring the MAC Address Table

MAC address table management includes:

- Setting MAC Address Table Entries
- Disabling or Enabling Global MAC Address Learning
- Disabling or Enabling MAC Address Learning on a Port
- Setting MAC Address Aging Time
- Setting the Maximum MAC Addresses an Ethernet Port can Learn
- Displaying and Debugging the MAC Address Table

Setting MAC Address Table Entries

You can manually add, modify, or delete entries in a MAC address table according to actual needs. you can also delete all (unicast) MAC address table entries related to a specified port or delete a specified type of entries, such as dynamic or static entries.

Use the following commands to add, modify, or delete the entries in MAC address table.

Perform the following configuration in system view.

Table 15 Setting MAC Address Table Entries

Operation	Command
Add or modify an address entry	**mac-address** { **static | dynamic** } *hw-addr* **interface** { *interface-name* | *interface-type interface-num* }

Table 15 Setting MAC Address Table Entries

Operation	Command
Delete an address entry	**undo mac-address** [{ **static** | **dynamic** } mac-address **interface** { *interface-name* | *interface-type interface-num* } *vlan-id*]

Disabling or Enabling Global MAC Address Learning

With the address learning function enabled, an Ethernet switch can learn new MAC addresses. When it receives a packet destined for a MAC address it has already learned, the switch forwards the packet directly, instead of flooding all ports.

Sometimes, for the sake of security, it is necessary to disable the address learning function. A common threat is from hackers who attack the switch with packets from different source MAC addresses, thereby exhausting the address table resources and making it impossible for the switch to update the MAC address table to reflect network changes. Such an attack can be avoided by disabling the MAC address learning function.

You can use the following commands to disable or enable the MAC address learning globally.

Perform the following configuration in system view.

Table 16 Disabling or Enabling the MAC Address Learning

Operation	Command
Disable the MAC address learning	**mac-address mac-learning disable**
Enable the MAC address learning	**undo mac-address mac-learning disable**

By default, the MAC address learning function is enabled.

Disabling or Enabling MAC Address Learning on a Port

After the MAC address learning has been enabled globally, you can disable it on individual ports.

Use the following commands to disable the MAC address learning on a specified port.

Perform the following configurations in the Ethernet port view.

Table 17 Disable/Enable the MAC Address Learning

Operation	Command
Disable the MAC address learning	**mac-address mac-learning disable**
Enable the MAC address learning	**undo mac-address mac-learning disable**

By default, the MAC address learning function is enabled.

Setting MAC Address Aging Time

Setting an time implements MAC address aging. Too long or too short an aging time set by subscribers will cause the Ethernet switch to flood a large amount of data packets. This affects the switch operation performance.

If aging time is set too long, the Ethernet switch stores a great number of out-of-date MAC address in its table. This consumes MAC address table resources and the switch will not be able to update the MAC address table according to the network change.

If aging time is set too short, the Ethernet switch may delete valid MAC address table entries.

You can use the following commands to set the MAC address aging time for the system.

Perform the following configuration in system view.

Table 18 Setting the MAC Address Aging Time for the System

Operation	Command
Set the dynamic MAC address aging time	**mac-address timer** { **aging** *age* | **no-aging** }
Restore the default MAC address aging time	**undo mac-address timer aging-time**

This command takes effect on all the ports. However, the address aging only functions on the dynamic addresses (learned or configured as age entries by the user).

By default, the aging-time is 300 seconds. With the no-aging parameter, the command performs no aging on the MAC address entries.

Setting the Maximum MAC Addresses an Ethernet Port can Learn

Use the following command to set an amount limit on MAC addresses learned by the Ethernet port. If the number of MAC addresses learned by this port exceeds the value set by the user, this port will not learn MAC address.

Perform the following configuration in Ethernet port view.

Table 19 Setting an Amount Limit to the MAC Addresses Learned by the Ethernet Port

Operation	Command
Set an amount limit to the MAC addresses learned by the Ethernet port	**mac-address max-mac-count** *count*
Restore the default limit to the MAC addresses learned by the Ethernet port	**undo mac-address max-mac-count**

NOTE: *If the count parameter is set to 0, the port is not permitted to learn MAC address. By default, there is no limit to the amount of the MAC addresses that an Ethernet port can learn. However, the number of MAC addresses a port can learn is restricted by the size of the MAC address table.*

Displaying and Debugging the MAC Address Table

Execute the **display** command in all views to display the MAC address table configuration, and to verify the effect of the configuration.

Execute the **debugging** command in user view to debug MAC address table configuration.

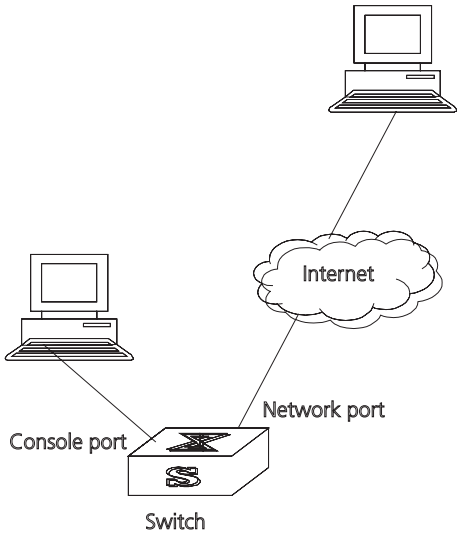
Table 20 Displaying and Debugging MAC Address Table

Operation	Command
Display the information in the address table	**display mac-address** [**static** | **dynamic**] [[**interface** { *interface-name* | *interface-type interface-num* }] [**vlan** *vlan-id*]]
Display the aging time of dynamic address table entries	**display mac-address aging-time**
Display the dynamic MAC address learning capability of the system and ports	**display mac-address learning** [*interface-type interface-num* | *interface-name*]
Enable the address table management debugging	**debugging mac-address**
Disable the address table management debugging	**undo debugging mac-address**

Example: Configuring MAC Address Table Management

The user logs in to the switch through the console port to configure the address table management. Set the address aging time to 500s and add a static address 00e0-fc35-dc71 to GigabitEthernet1/1/2 in vlan1.

Figure 2 Typical Configuration of Address Table Management



1 Enter the system view of the switch.

```
<SW8800>system-view
```

2 Add a MAC address (specify the native VLAN, port and state).

```
[SW8800]mac-address static 00e0-fc35-dc71 interface
GigabitEthernet1/1/2 vlan 1
```

3 Set the address aging time to 500s.

```
[SW8800]mac-address timer 500
```

4 Display the MAC address configurations in all views.

```
[SW8800]display mac-address interface Ethernet 1/1/2
MAC ADDR           VLAN ID   STATE  PORT INDEX  AGING TIME(s)
00-e0-fc-35-dc-71  1         Static Ethernet1/1/2  NOAGED
```

```
00-e0-fc-17-a7-d6  1          LearnedEthernet1/1/2  300
00-e0-fc-5e-b1-fb  1          Learned Ethernet1/1/2  300
00-e0-fc-55-f1-16  1          Learned Ethernet1/1/2  300
```

Managing Devices

With device management, the Switch 8800 displays the current state and event debugging information about the slots and physical devices. In addition, there is a command for rebooting the system when a function failure occurs.

Configuring the Managing Devices is described in the following sections:

- Rebooting the Switch 8800
- Designating the File for the Next Boot
- Displaying Devices

Rebooting the Switch 8800

Perform the following configuration in user view.

Table 21 Rebooting the Switch 8800

Operation	Command
Reboot the Switch 8800	**reboot**

Designating the File for the Next Boot

In the case that there are several operational images in the flash memory, you can use this command to designate the file (*.app) to use when the Switch 8800 is booted.

Perform the following configuration in user view.

Table 22 Designating the APP for the next boot

Operation	Command
Designate the APP for the next boot	**boot boot-loader** *file-url*

Tasks for designating the file for the next boot are described in the following sections:

- Upgrading BootROM
- Resetting a Slot
- Setting the Slot Temperature Limit

Upgrading BootROM

You can use this command to upgrade the BootROM with the BootROM program in the flash memory. This configuration task facilitates the remote upgrade. You can upload the BootROM program file, from a remote end to the switch, by FTP and then use this command to upgrade the BootROM on the modules.

Perform the following configuration in user view.

Table 23 Upgrading BootROM

Operation	Command
Upgrade BootROM	**boot BootROM** file-url

Resetting a Slot

The Switch 8800 allows the administrator to reset a slot in the system.

Perform the following configuration in user view.

Table 24 Resetting a Slot

Operation	Command
Reset a slot	**reboot** [**slot** *slot-num*]

The parameter *slot-num* ranges from 0 to 13, depending on the chassis. Setting the parameter to 0 resets the fabric module, taking the same effect as resetting the entire system. Setting the parameter from 1 through 13 resets the I/O modules in the corresponding slots.

If you input **reboot** without specifying a slot number, the whole system will be reset.

Setting the Slot Temperature Limit

When the temperature on a slot exceeds the preset limit, the Switch 8800 sounds an alarm at the system and sends an SNMP trap to the network management station.

Perform the following configuration in user view.

Table 25 Setting the Slot Temperature Limit

Operation	Command
Set slot temperature limit	**temperature-limit slot** *down-value up-value*

Displaying Devices

Execute the **display** command in all views to display the device management configuration, and to verify the configuration.

Table 26 Displaying Devices

Operation	Command
Display the CPU	**display cpu** [**slot** *slotnum*]
Display the module types and states of each card	**display device** [**detail** | { **shelf** *shelf-no* | **frame** *frame-no* | **slot** *slot-no* }*]
Display the state of the built-in fans	**display fan** [*fan-id*]
Display the information about the environment	**display environment**
Display the used status of switch memory	**display memory** [**slot** *slot-number*]
Display the state of the power	**display power** [*power-ID*]

Maintaining and Debugging the System

This section includes descriptions of the following types of system maintenance ad debugging:

- Configuring System Basics
- Displaying System Information and State
- Debugging the System

- Testing Tools for Network Connection
- Logging Function

Configuring System Basics

This section describes the following basic system configuration tasks:

- Setting the System Name
- Setting the System Clock
- Setting the Time Zone
- Setting Daylight Saving Time

Setting the System Name

Perform the following commands in system view.

Table 27 Setting the System Name

Operation	Command
Set the switch name	**sysname** *sysname*
Restore the switch name to the default name	**undo sysname**

Setting the System Clock

Perform the following command in user view.

Table 28 Setting the System Clock

Operation	Command
Set the system clock	**clock datetime** *HH:MM:SS YYYY/MM/DD*

Setting the Time Zone

You can configure the name of the local time zone, and the time difference between the local time and the standard Universal Time Coordinated (UTC).

Perform the following commands in user view.

Table 29 Setting the Time Zone

Operation	Command
Set the local time	**clock timezone** *zone_name* { **add** | **minus** } *HH:MM:SS*
Restore to the default UTC time zone	**undo clock timezone**

By default, the UTC time zone is set.

Setting Daylight Saving Time

Use these commands to configure the start and end time of daylight saving time.

Perform this command in user view.

Table 30 Setting Daylight Saving Time

Operation	Command
Set the name and range of daylight saving time	**clock summer-time** *zone_name* { **one-off** | **repeating** } *start-time start-date end-time end-date offset-time*
Remove the setting of the summer time	**undo clock summer-time**

By default, daylight saving time is not set.

Displaying System Information and State

The following display commands are used for displaying the system state and the statistics information. For the display commands related to each protocol and different ports, refer to the appropriate chapters.

Perform the following operations in all views.

Table 31 The Display Commands of the System

Operation	Command
Display the system clock	**display clock**
Display the system version	**display version**
Display the terminal user	**display users** [**all**]
Display the saved-configuration	**display saved-configuration**
Display the current-configuration	**display current-configuration** [**controller | interface** *interface-type* [*interface-number*] | **configuration** [*configuration*] [| { begin | exclude | **include** } *regular-expression*]
Display the state of the debugging	**display debugging** [**interface** { *interface-name* | *interface-type interface-number* }] [*module-name*]

Debugging the System

Tasks for debugging the system are described in the following sections:

- Enabling and Disabling Terminal Debugging
- Displaying Diagnostic Information

Enabling and Disabling Terminal Debugging

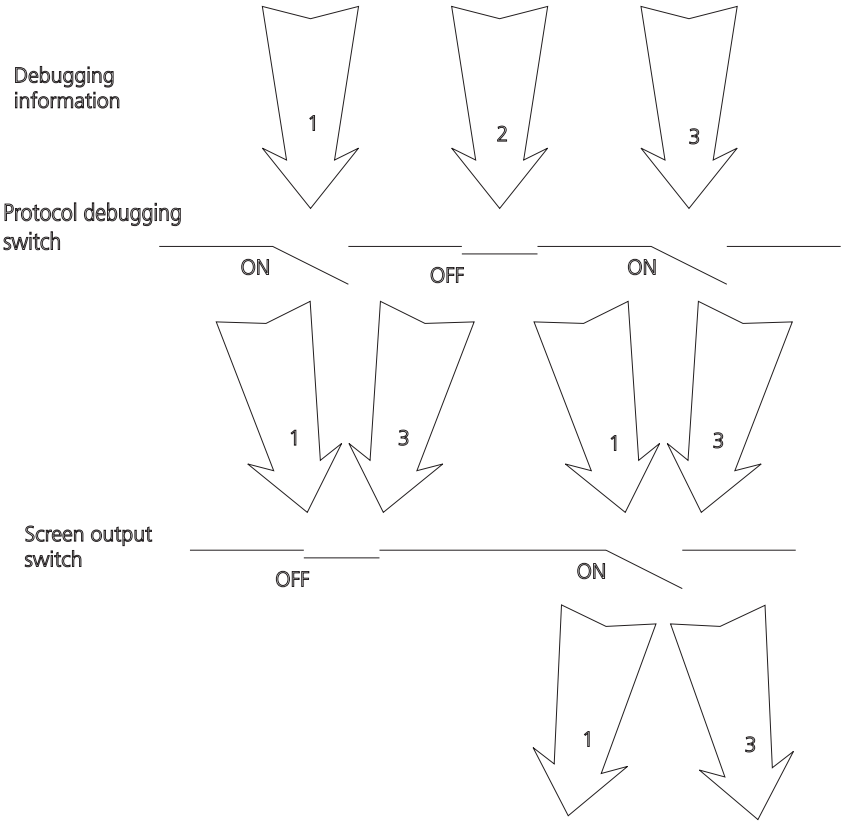
The Switch 8800 provides various ways for debugging most of the supported protocols and functions.

The following switches control the outputs of debugging information:

- The protocol debugging switch controls debugging output of a protocol.
- The terminal debugging switch controls debugging output on a specified user screen.

Figure 3 illustrates the relationship between two switches.

Figure 3 Debugging Output



You can use the following commands to control debugging.

Perform the following operations in user view.

Table 32 Enabling and Disabling Debugging

Operation	Command
Enable the protocol debugging	**debugging** { **all** [**timeout** *interval*] | *module-name* [*debugging-option*] }
Disable the protocol debugging	**undo debugging** { **all** | { *protocol-name* | *function-name* } [*debugging-option*] }
Enable the terminal debugging	**terminal debugging**
Disable the terminal debugging	**undo terminal debugging**

For more about the usage and format of the debugging commands, refer to the appropriate chapters.

*Since the debugging output will affect the system operating efficiency, do not enable the debugging command unnecessarily. Use the **debugging all** command, especially, with caution. When the debugging is over, disable all debugging.*

Displaying Diagnostic Information

You can collect information about the switch to locate the source of faults. Each module has a corresponding display command, which makes it difficult to collect all the information needed. In this case, use **display diagnostic-information** command.

You can perform the following operations in all views.

Table 33 Displaying Diagnostic Information

Operation	Command
Display diagnostic information	**display diagnostic-information**

To view the data later, enable saving a screen capture to a file.

Testing Tools for Network Connection

The descriptions of testing tools for a network connection are found in the following:

- Ping
- Tracert Command

Ping

The **ping** command can be used to check the network connection and to verify whether the host can be reached.

Perform the following operation in user view.

Table 34 The Ping Command

Operation	Command
Support IP ping	**ping** [-**a** *ip-address*] [**-c** *count*] [**-d**] [-**i** {*interface-type interface-num* **|** *interface-name* }][**ip**] [**-n**] [**- p** *pattern*] [**-q**] [**-r**][**-s** *packetsize*] [**-t** *timeout*] [**-v**] *host*

The output of the **ping** command includes:

- The response to each ping message. If no response packet is received when time is out,"Request time out" information appears. Otherwise, the data bytes, the packet sequence number, TTL, and the round-trip time of the response packet will be displayed.
- The final statistics, which include the:
  - number of the packets the switch sent out and received
  - packet loss ratio
  - round-trip time in its minimum value, mean value and maximum value

Tracert Command

Tracert is used for testing the gateways from the source host to the destination. It is used for checking if the network is connected and analyzing where faults occur in the network.

The following list provides the tracert execution process:

1. Tracert sends a packet with TTL value of 1.
2. The first hop sends back an ICMP error message indicating that the packet cannot be sent, for the TTL is timeout.
3. Re-send the packet with TTL value of 2.
4. The second hop returns the TTL timeout message.

The process is repeated until the packet reaches the destination. The process is to record the source address of each ICMP TTL timeout message to provide the route of an IP packet to the destination.

Perform the following operation in user view.

Table 35 The Tracert Command

Operation	Command
Trace a route	**tracert** [**-f** *first-TTL*] [**-m** *max-TTL*] [**-p** *port*] [**-q** *nqueries*] [**-w** *timeout*] *host*

Logging Function

The syslog characterizes the behavior of the Switch 8800. It serves as an information center of the system software modules. The logging system is responsible for most of the information output, and also to make detailed classification to filter the information efficiently. Coupled with the debugging program, the syslog provides powerful support for the network administrators to monitor the operational state of networks and to diagnose network failures.

The syslog of the Switch 8800 has the following features:

- Support for six different output destinations: console, monitor to Telnet terminal, log buffer, loghost, trap buffer, and SNMP.
- The log is divided into 8 levels according to the significance of the event, and it can be filtered based on the levels.
- The information can be classified in terms of the source modules, and the information can be filtered by module.
- The output language can be selected between English and Chinese.

SYSLOG configuration includes tasks described in the following sections:

- Enabling and Disabling the Logging Function
- Setting the Output Channel of the Log
- Defining the Log Filtering Rules
- Configuring the SNMP Timestamp Output Format
- Displaying and Debugging the Syslog Function

For the above configuration, the log host is not configured on the switch. All other configurations will take effect after enabling the logging function.

Enabling and Disabling the Logging Function

You can use the following commands to enable or disable the logging function.

Perform the following operation in system view.

Table 36 Enable/Disable the Logging Function

Operation	Command
Enable the logging function.	**info-center enable**
Disable the logging function.	**undo info-center enable**

By default, syslog is disabled. When syslog is enabled, system performance is affected by the information classification and the output, especially when there is a large amount of information to be processed.

Setting the Output Channel of the Log

The syslog of the Ethernet switch has six possible output destinations. Use the configuration commands to specify the required channels for syslog output. All the information will be filtered by the specified channel and then transmitted to the configured destination. You can configure the channel and filtering information for every destination to implement the filtering and redirection of different information.

Use the following commands to configure the output channel of the log.

Perform the following configuration in system view.

Table 37 Log Output

Operation	Command
Configure to output the information to the Console	**info-center console channel** { *channel-number* | *channel-name* }
Disable the output of the information to the Console	**undo info-center console channel**
Configure to output the information to the Telnet terminal or monitor	**info-center monitor channel** { *channel-number* | *channel-name* }
Disable the output of the information to the Telnet terminal or monitor	undo info-center monitor channel
Configure to output the information to the logging buffer.	**info-center logbuffer** [**size** *buffersize*] [**channel** { *channel-number* | *channel-name* }]
Disable the output of the information to the logging buffer.	**undo info-center logbuffer** [**channel | size**]
Configure to output the information to the info-center loghost.	**info-center loghost** *host-ip-addr* [**channel** { *channel-number* | *channel-name* }] [**facility** *local-number*] [**language** { **chinese | english** }]
Disable the output of the information to the info-center loghost.	**undo info-center loghost** *host-ip-addr*
Set the address of the interface specified by *interface-name as* the source address for packets sent to loghost	**info-center loghost source** *interface-name*
Cancel the source address setting for the packets sent to loghost	**undo info-center loghost source**
Configure to output the information to the trap buffer.	**info-center trapbuffer** [**size** *buffersize*] [**channel** { *channel-number* | *channel-name* }]
Disable the output of the information to the trap buffer.	**undo info-center trapbuffer [channel | size**]
Configure to output the information to SNMP.	**info-center snmp channel** { *channel-number* | *channel-name* }
Disable the output of the information to SNMP.	**undo info-center snmp channel**
Rename a channel specified by *channel-number* as *channel-name*	**info-center channel** *channel-number* **name** *channel-name*

The system assigns a channel in each output direction by default. See Table 38.

Table 38 Numbers and Names of the Channels for Log Output

Name	Channel number	Default channel name
Console	0	console
Monitor	1	monitor
Info-center loghost	2	loghost
Trap buffer	3	trapbuf
Logging buffer	4	logbuf
SNMP	5	snmpagent

The six settings are independent from each other. The settings will take effect only after enabling the information center.

Defining the Log Filtering Rules

The SYSLOG classifies the information into eight levels of severity. The log filtering prevents the system from outputting information whose severity level is greater than the set threshold. The more urgent the logging packet is, the lower its severity level. The level for emergencies is 1, and the level for debugging is 8. Therefore, when the threshold of the severity level is 8, the system will output all information.

Table 39 Syslog-Defined Severity

Severity	Description
1 Emergencies	The extremely emergent errors
2 Alerts	The errors that need to be corrected immediately.
3 Critical	Critical errors
4 Errors	The errors that need to be addressed but are not critical
5 Warnings	Warning, there might be an error
6 Notifications	The information should be read
7 Informational	Common prompting information
8 Debugging	Helpful information for debugging

Use the following commands to define the filtering rules of the channels.

Perform the following operation in system view.

Table 40 Define the Filtering Rules of the Channels

Operation	Command
Add the filtering record about a certain type of information in a module to the information channel	**info-center source** { *module-name* | **default** } **channel** { *channel-number* | *channel-name* } [{ **log** | **trap** | **debug** } * { **level** *severity* | **state** *state*] } *
Delete the filtering record about a certain type of information in a module or all the modules from the channel	**undo info-center source** { *modu-name* | **default** } **channel** { *channel-number* | *channel-name* }

module-name specifies the module name. **level** refers to the severity levels and *severity* specifies the severity level of information. The information with the level below it will not be output. *channel-number* specifies the channel number and *channel-name* specifies the channel name.

Every channel has been set with a default record, whose module name is **default** and the module number is 0xffff0000. However, for different channels, the default record may have different default settings of log, trap and debugging. When there is no specific configuration record for a module in the channel, use the default one.

When there is more than one Telnet user or monitor user at the same time, some configuration parameters are shared among the users, such as module-based filtering settings and the severity threshold. When you modify these settings, the changes affect all users.

Configuring the SNMP Timestamp Output Format

Perform the following operation in system view.

Table 41 Configuring the SNMP Timestamp Output Format

Operation	Command
Configure the SNMP Timestamp Output Format	**info-center timestamp** { **log** | **trap** | **debugging** } { **boot** | **date** | **none** }
Disable the output of the timestamp field	**undo info-center timestamp** { **log** | **trap** | **debugging** }

Displaying and Debugging the Syslog Function

After performing the syslog configuration, execute the **display** command in all views to display the configuration and to verify the effect of the configuration. Execute the **reset** command in user view to clear the statistics of the syslog module. Execute the **debugging** command in user view to debug the syslog module.

Perform the following configuration in system view.

Table 42 Displaying and Debugging the Syslog Function

Operation	Command
View details about the information channel	**display channel** [*channel-number* | *channel-name*]
View the configuration of the system log and the information recorded in the memory buffer	**display info-center**
Reset the information in the log buffer	**reset logbuffer**
Reset the information in the trap buffer	**reset trapbuffer**
Enable terminal log information display	**terminal logging**
Disable terminal log information display	**undo terminal logging**
Enable the log debugging/log/trap on the terminal monitor	**terminal monitor**
Disable the log debugging/log/trap on the terminal monitor	**undo terminal monitor**
Enable terminal trap information display	**terminal trapping**
Disable terminal trap information display	**undo terminal trapping**

SNMP

The Simple Network Management Protocol (SNMP) is used for transmitting management information between any two nodes. In this way, network administrators can easily search and modify the information on any node on the network. They can also locate faults promptly and implement the fault diagnosis, capacity planning, and report generating. SNMP adopts the polling mechanism and provides the most basic function set. It is most applicable to the small-sized, fast-speed, and low-cost environment. It only requires the unverified transport layer protocol UDP, and is widely supported by many other products.

In terms of structure, SNMP can be divided into two parts, NMS and Agent. NMS (Network Management Station) is the workstation for running the client program. At present, the commonly used NM platforms include Sun NetManager and IBM NetView. The agent is the server software operated on network devices. NMS can send GetRequest, GetNextRequest, and SetRequest messages to the agent. Upon receiving the requests from the NMS, the agent will perform a read or write operation according to the message types, and generate and return the response message to NMS. On the other hand, the agent will send a trap message on its own initiative to NMS to report events whenever the device encounters any abnormalities.

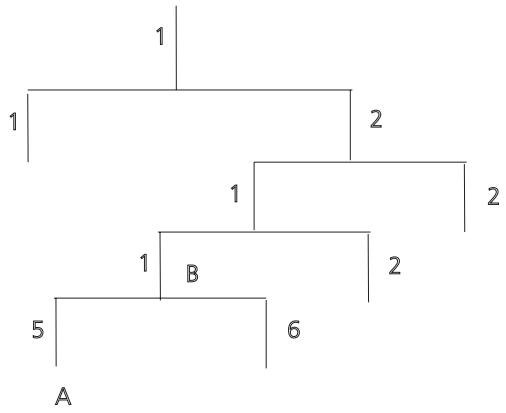
Configuring SNMP is described in the following sections:

- SNMP Versions and Supported MIB
- Configuring SNMP

SNMP Versions and Supported MIB

To uniquely identify the management variables of a device in SNMP messages, SNMP adopts the hierarchical naming scheme to identify the managed objects. It is like a tree. A tree node represents a managed object, as shown in the figure below. Thus the object can be identified with the unique path starting from the root.

Figure 4 Architecture of the MIB Tree



The MIB (Management Information Base) is used to describe the hierarchical architecture of the tree, and is the set defined by the standard variables of the monitored network device. In the above figure, the managed object B can be uniquely specified by a string of numbers {1.2.1.1}. The number string is the Object Identifier of the managed object.

The current SNMP Agent of Ethernet switch supports SNMP V1, V2C and V3. The MIBs supported are listed in the following table.

Table 43 MIBs Supported by the Switch 8800

MIB Attribute	MIB Content	References
Public MIB	MIB II based on TCP/IP network device	RFC1213
	BRIDGE MIB	RFC1493
		RFC2675
	RIP MIB	RFC1724
	RMON MIB	RFC2819
	Ethernet MIB	RFC2665
	OSPF MIB	RFC1253
	IF MIB	RFC1573
Private MIB	DHCP MIB	
	QACL MIB	
	ADBM MIB	
	RSTP MIB	
	VLAN MIB	
	Device management	
	Interface management	

Configuring SNMP

Configuring SNMP includes tasks that are described in the following sections:

- Setting the Community Name
- Enabling and Disabling the SNMP Agent to Send a Trap
- Setting the Destination Address of a Trap
- Setting the Lifetime of the Trap Message
- Setting SNMP Information
- Setting the Engine ID of a Local or Remote Device
- Setting and Deleting an SNMP Group
- Setting the Source Address of the Trap
- Adding and Deleting a User to or from an SNMP Group
- Creating and Updating View Information or Deleting a View
- Setting the Size of an SNMP Packet Sent or Received by an Agent
- Enabling and Disabling Transmission of Trap Information
- Disabling the SNMP Agent
- Displaying and Debugging SNMP

Setting the Community Name

SNMP v1, and SNMP v2C, and SNMP v3 use the community name authentication scheme. An SNMP message that does not comply with the community name that is accepted by the device is discarded. An SNMP community is named with a character string, which is called the community name. Communities can have read-only or read-write access modes. A community with read-only authority can

only query the device information, whereas the community with read-write authority can also configure the device.

Use the following commands to set the community name.

Perform the following configuration in system view.

Table 44 Setting the Community Name

Operation	Command
Set the community name and the access authority	**snmp-agent community** { **read** | **write** } *community-name* [[**mib-view** *view-name*] [**acl** *acl-list*]]
Remove the community name and the access authority	**undo snmp-agent community** *community-name*

Enabling and Disabling the SNMP Agent to Send a Trap

The managed device transmits a trap without a request to the NMS to report critical and urgent events, such as a restart.

You can use the following commands to enable or disable the managed device to transmit a trap message.

Perform the following configuration in system view.

Table 45 Enabling and Disabling an SNMP Agent to Send a Trap

Operation	Command
Enable to send a trap	**snmp-agent trap enable** [**standard** [**authentication**] [**coldstart**] [**linkdown**] [**linkup**] [**warmstart**]]
Disable to send a trap	**undo snmp-agent trap enable** [**standard** [**authentication**] [**linkdown**] [**linkup**] [**coldstart**] [**warmstart**]]

Setting the Destination Address of a Trap

You can use the following commands to set or delete the destination address of the trap.

Perform the following configuration in system view.

Table 46 Setting the Destination Address of a Trap

Operation	Command
Set the destination address of trap	**snmp-agent target-host trap address udp-domain** *host-addr* [**udp-port** *udp-port-number*] **params securityname** *community-string* [**v1** | **v2c** | **v3** { **authentication** | **privacy** }]
Delete the destination address of trap	**undo snmp-agent target-host** *host-addr* **securityname** *community-string*

The **authentication** parameter specifies that the packet is authenticated *without* encryption. This parameter is supported only in SNMP V3.

The **privacy** parameter specifies that the packet is authenticated and encrypted. This parameter is supported only in SNMP V3.

Setting the Lifetime of the Trap Message

You can use the following command to set lifetime of a trap message. A trap message that exists longer than the set lifetime will be dropped.

Perform the following configuration in system view.

Table 47 Setting the Lifetime of the Trap Message

Operation	Command
Set lifetime of Trap message	**snmp-agent trap life** *seconds*
Restore lifetime of Trap message	**undo snmp-agent trap life**

By default, the lifetime of a trap message is 120 seconds.

Setting SNMP Information

The SNMP system information includes the character string sysContact (system contact), the character string describing the system location, and the version information for SNMP in the system.

Use the following commands to set the system information.

Perform the following configuration in system view.

Table 48 Setting SNMP System Information

Operation	Command
Set SNMP system information	**snmp-agent sys-info** { **contact** *sysContact* | **location** *syslocation* | **version** { { **v1** | **v2c** | **v3**] * | **all** } }
Restore the default SNMP system information of the Ethernet switch	**undo snmp-agent sys-info** [{ **contact** | **location** }* | **version** { { **v1** | **v2c** | **v3**] * | **all** }]

By default, *syslocation* is specified as "Marlborough MA".

Setting the Engine ID of a Local or Remote Device

Use the following commands to set the engine ID of a local or remote device.

Perform the following configuration in system view.

Table 49 Setting the Engine ID of a Local or Remote Device

Operation	Command
Set the engine ID of the device	**snmp-agent local-engineid** *engineid*
Restore the default engine ID of the device.	**undo snmp-agent local-engineid** *engineid*

By default, the engine ID is expressed as enterprise No. + device information. The device information can be IP address, MAC address, or user-defined text.

Setting and Deleting an SNMP Group

Use the following commands to set or delete an SNMP group.

Perform the following configuration in system view.

Table 50 Setting and Deleting an SNMP Group

Operation	Command
Setting an SNMP group	**snmp-agent group** *group-name* { **v1 | v2c** } [**read-view** *read-view*] [**write-view** *write-view*] [**notify-view** *notify-view*] [**acl** *acl-list*]
	snmp-agent group *group-name* **v3** [**authentication** | **privacy**] [**read-view** *read-view*] [**write-view** *write-view*] [**notify-view** *notify-view*] [**acl** *acl-list*]
Deleting an SNMP group	**undo snmp-agent group** *group-name* { **v1 | v2c** }
	undo snmp-agent group *group-name* **v3** [**authentication** | **privacy**]

The **authentication** parameter specifies that the packet is authenticated *without* encryption. This parameter is supported only in SNMP V3.

The **privacy** parameter specifies that the packet is authenticated *and* encrypted. This parameter is supported only in SNMP V3.

Setting the Source Address of the Trap

Use the following commands to set or remove the source address of the trap.

Perform the following configuration in system view.

Table 51 Setting the Source Address of the Trap

Operation	Command
Set the Source Address of Trap	**snmp-agent trap source** *interface-name interface-num*
Remove the source address of trap	**undo snmp-agent trap source**

Adding and Deleting a User to or from an SNMP Group

Use the following commands to add or delete a user to or from an SNMP group.

Perform the following configuration in system view.

Table 52 Adding and Deleting a User to or from an SNMP Group

Operation	Command
Add a user to an SNMP group	**snmp-agent usm-user** { **v1 | v2c** } *username groupname* [**acl** *acl-list*]
	snmp-agent usm-user v3 *username groupname* [**authentication-mod** { **md5 | sha** } *auth_password* [**privacy-mod** { **des56** *priv_password* }]] **acl** *acl-list*
Delete a user from an SNMP group	**undo snmp-agent usm-user** { **v1** | **v2c** } *username groupname*
	undo snmp-agent usm-user v3 *username groupname* { **local | engineid** *engine-id* }

The **authentication-mode** parameter specifies the use of authentication. The **privacy-mode** parameter specifies the use of authentication and encryption. This parameter is supported only in SNMP V3.

For details, see the *Switch 8800 Command Reference Guide*.

Creating and Updating View Information or Deleting a View

Use the following commands to create, update the information of views, or delete a view.

Perform the following configuration in system view.

Table 53 Creating and Updating View Information or Deleting a View

Operation	Command
Create or update view information	**snmp-agent mib-view** { **included** | **excluded** } *view-name oid-tree*
Delete a view	**undo snmp-agent mib-view** *view-name*

Setting the Size of an SNMP Packet Sent or Received by an Agent

Use the following commands to set the size of SNMP packet sent or received by an agent.

The agent can receive or send the SNMP packets ranging from 484 bytes to 17940 bytes. By default, the size of an SNMP packet is 1500 bytes.

Perform the following configuration in system view.

Table 54 Setting the Size of an SNMP Packet Sent or Received by an Agent

Operation	Command
Set the size of an SNMP packet set or received by an agent	**snmp-agent packet max-size** *byte-count*
Restore the default size of an SNMP packet sent or received by an agent	**undo snmp-agent packet max-size**

Enabling and Disabling Transmission of Trap Information

To enable or disable transmission of trap information, perform the following configuration in Ethernet port view.

Table 55 Enable/Disable Transmission of Trap Information

Operation	Command
Enable the current port to transmit the trap information	**enable snmp trap updown**
Disable the current port from transmitting trap information	**undo enable snmp trap updown**

Disabling the SNMP Agent

To disable the SNMP Agent, perform the following configuration in system view.

Table 56 Disabling SNMP Agent

Operation	Command
Disable snmp agent	**undo snmp-agent**

If a user disables an NMP Agent, it is enabled whatever **snmp-agent** command is configured.

Displaying and Debugging SNMP

Execute the **display** command to view the SNMP configuration and to verify the effect of the configuration. Execute the **debugging** command in user view to debug the SNMP configuration.

Table 57 Displaying and Debugging SNMP

Operation	Command
Display the statistics information about SNMP packets	**display snmp-agent statisitcs**
Display the engine ID of the active device	**display snmp-agent** { *local-engineid* | *remote-engineid* }
Display the group name, the security mode, the states for all types of views, and the storage mode of each group of the switch.	**display snmp-agent group**
Display the names of all users in the group user table	**display snmp-agent usm-user** [{ **local** | { **engineid** *engineid* } } | *username groupname*]
Display the current community name	**display snmp-agent community** [**read | write**]
Display the current MIB view	**display snmp-agent mib-view** [**exclude | include | viewname** *mib-view*]
Display the contact character string of the system	**display snmp-agent sys-info contact**
Display the location character string of the system	**display snmp-agent sys-info location**
Display the version character string of the system	**display snmp-agent sys-info version**

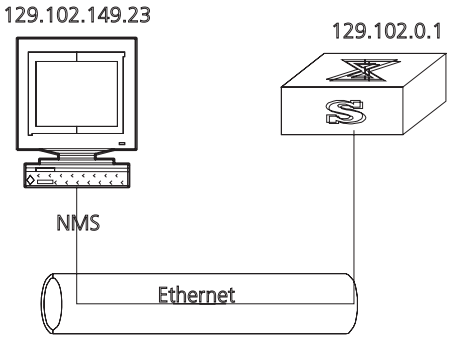
Example: SNMP Configuration

The IP address of NMS is 129.102.149.23 and the IP address of the VLAN interface on the switch is 129.102.0.1.

Perform the following configurations on the switch:

- Set the community name and access authority
- Set the administrator ID, contact and switch location
- Enable the switch to send a trap packet.

Figure 5 SNMP Configuration Example



1 Enter the system view.

```
<SW8800>system-view
```

2 Set the community name, group name, and user.

```
[SW8800]snmp-agent sys-info version all
[SW8800]snmp-agent community write public
[SW8800]snmp-agent mib include internet 1.3.6.1
[SW8800]snmp-agent group v3 managev3group write internet
[SW8800]snmp-agent usm v3 managev3user managev3group
```

3 Set the administrator ID, contact and the physical location of the Ethernet switch.

```
[SW8800]snmp-agent sys-info contact Mr.Smith-Tel:3306
[SW8800]snmp-agent sys-info location telephone-closet, 3rd-floor
```

4 Set the VLAN interface 2 as the interface used by network management. Add Ethernet port 2/1/3 to the VLAN 2. This port will be used for network management. Set the IP address of VLAN interface 2 as 129.102.0.1.

```
[SW8800]vlan 2
[SW8800-vlan2]port ethernet 2/1/3
[SW8800-vlan2]interface vlan 2
[SW8800-Vlan-interface2]ip address 129.102.0.1 255.255.255.0
```

5 Set the administrator ID, contact and the physical location of the Ethernet switch.

```
[SW8800]snmp-agent sys-info contact Mr.Smith-Tel:3306
[SW8800]snmp-agent sys-info location telephone-closet,3rd-floor
```

6 Enable the SNMP agent to send the trap to Network Management Station whose IP address is 129.102.149.23. The SNMP community is public.

```
[SW8800]snmp-agent trap enable standard authentication
[SW8800]snmp-agent trap enable standard coldstart
[SW8800]snmp-agent trap enable standard linkup
[SW8800]snmp-agent trap enable standard linkdown
[SW8800]snmp-agent target-host trap address udp-domain
129.102.149.23 udp-port 5000 params securityname public
```

RMON

Remote Network Monitoring (RMON) is an IETF-defined MIB. It is the most important enhancement to the MIB II standard. It is used for monitoring the data traffic on a segment and even on a whole network. It is one of the most widely used network management standards.

RMON is based on the SNMP architecture and is compatible with the existing SNMP framework, so it is not necessary to adjust the protocol. RMON includes

NMS and the agent running on the network devices. On the network monitor or detector, RMON agent tracks and accounts for different traffic information on the segment connected to its port. For example, the total number of packets on a segment in a certain period of time or that of the correct packets sent to a host.

RMON helps the SNMP monitor the remote network device more actively and effectively, which provides a highly efficient means for monitoring subnet operations. RMON can reduce communication traffic between the NMS and the agent, thus facilitating an effective management over large interconnected networks.

RMON allows multiple monitors. It can collect data in two ways.

1. The first way is with a special RMON probe. NMS directly obtains the management information from the RMON probe and controls the network resource. In this way, it obtains all the information of RMON MIB.
2. The second way is to implant the RMON Agent directly into the network devices, such as routers, switches, hubs, and so on, so that the devices become network facilities with RMON probe functions. RMON NMS uses the basic SNMP commands to exchange data information with the SNMP Agent and to collect NM information. However, not all the data of the RMON MIB can be obtained with this method, depending on resources. In most cases, only four groups of information can be collected. The four groups are: trap information, event information, history information and statistics information.

The Switch 8800 implements RMON using the second method. With the RMON-supported SNMP agent running on the network monitor, NMS can obtain such information as the overall traffic of the segment connected to the managed network device port, the error statistics and performance statistics, thereby implementing the management (usually remote) over the network.

Configuring RMON

RMON configuration includes tasks described in the following sections:

- Adding and Deleting an Entry to or from the Alarm Table
- Adding and Deleting an Entry to or from the Event Table
- Adding and Deleting an Entry to or from the History Control Table
- Adding and Deleting an Entry to or from the Extended RMON Alarm Table
- Adding and Deleting an Entry to or from the Statistics Table
- Displaying the RMON Configuration

Adding and Deleting an Entry to or from the Alarm Table

RMON alarm management can monitor the specified alarm variables, such as, statistics on a port. When a value of the monitored data exceeds the defined threshold, an alarm event will be generated. Generally, the event will be recorded in the device log table and a Trap message will be sent to NMS. The events are defined in event management. The alarm management includes browsing, adding and deleting alarm entries.

Use the following commands to add or delete an entry to or from the alarm table.

Perform the following configuration in system view.

Table 58 Adding or Delete an Entry to or from the Alarm Table

Operation	Command
Add an entry to the alarm table.	**rmon alarm** *entry-number alarm-variable sampling-time* { **delta | absolute** } **rising-threshold** *threshold-value1 event-entry1* **falling-threshold** *threshold-value2 event-entry2* [**owner** *text*]
Delete an entry from the alarm table.	**undo rmon alarm** *entry-number*

Adding and Deleting an Entry to or from the Event Table

RMON event management defines the event ID and handling of the event by keeping logs, sending trap messages to NMS, or performing both at the same time.

Use the following commands to add or delete an entry to or from the event table.

Perform the following configuration in system view.

Table 59 Add or Delete an Entry to or from the Event Table

Operation	Command
Add an entry to the event table	**rmon event** *event-entry* [**description** *string*] { **log** | **trap** *trap-community* | **log-trap** *log-trapcommunity* | **none** } [**owner** *rmon-station*]
Delete an entry from the event table	**undo rmon event** *event-entry*

Adding and Deleting an Entry to or from the History Control Table

The history data management helps you set the history data collection, periodical data collection, and storage of the specified ports. The sampling information includes the utilization ratio, error counts, and the total number of packets.

Use the following commands to add or delete an entry to or from the history control table.

Perform the following configuration in Ethernet port view.

Table 60 Adding or Deleting an Entry to or from the History Control Table

Operation	Command
Add an entry to the history control table	**rmon history** *entry-number* **buckets** *number* **interval** *sampling-interval* [**owner** *text-string*]
Delete an entry from the history control table	**undo rmon history** *entry-number*

Adding and Deleting an Entry to or from the Extended RMON Alarm Table

You can use the command to add or delete an entry to or from the extended RMON alarm table.

Perform the following configuration in system view.

Table 61 Add or Delete an Entry to or from the Extended RMON AlarmTable

Operation	Command
Add an entry to the extended RMON alarm table	**rmon prialarm** *entry-number alarm-var* [*alarm-des*] *sampling-timer* { **delta** | **absolute** | **changeratio** } **rising-threshold** *threshold-value1 event-entry1* **falling-threshold** *threshold-value2 event-entry2* **entrytype** { **forever | cycle** *cycle-period* } [**owner** *text*]
Delete an entry from the extended RMON alarm table	**undo rmon prialarm** *entry-number*

Adding and Deleting an Entry to or from the Statistics Table

The RMON statistics management concerns port usage monitoring and error statistics when using the ports. The statistics include collision, CRC and queuing, undersize packets or oversize packets, timeout transmission, fragments, broadcast, multicast and unicast messages, and the usage ratio of bandwidth.

Use the following commands to add or delete an entry to or from the statistics table.

Perform the following configuration in Ethernet port view.

Table 62 Add or Delete an Entry to or from the Statistics Table

Operation	Command
Add an entry to the statistics table	**rmon statistics** *entry-number* [**owner** *text-string*]
Delete an entry from the statistics table	**undo rmon statistics** *entry-number*

Displaying the RMON Configuration

Execute the **display** command in all views to display the RMON configuration, and to verify the configuration.

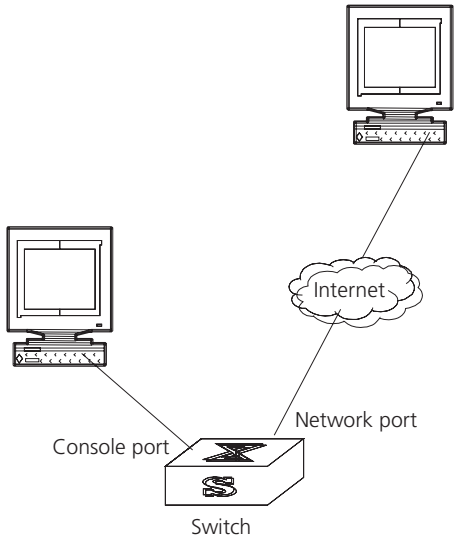
Table 63 Displaying and Debugging RMON

Operation	Command
Display the RMON statistics	**display rmon statistics** [port-num]
Display the history information of RMON	**display rmon history** [*port-num*]
Display the alarm information of RMON	**display rmon alarm** [*alarm-table-entry*]
Display the extended alarm information of RMON	**display rmon prialarm** [*prialarm-table-entry*]
Display the RMON event	**display rmon event** [*event-table-entry*]
Display the event log of RMON	**display rmon eventlog** [*event-number*]

Example: RMON Configuration

Set an entry in the RMON Ethernet statistics table for Ethernet port performance, which is convenient for network administrators' query.

Figure 6 RMON Configuration Networking



1 Configure RMON.

```
[SW8800-Ethernet2/1/1]rmon statistics 1 owner 3com-rmon
```

2 View the configurations in user view.

```
<SW8800>display rmon statistics Ethernet2/1/1
Statistics entry 1 owned by 3com-rmon is VALID.
  Gathers statistics of interface Ethernet2/1/1. Received:
  octets              : 270149,packets          : 1954
  broadcast packets   :1570   ,multicast packets:365
  undersized packets  :0      ,oversized packets:0
  fragments packets   :0      ,jabbers packets  :0
  CRC alignment errors:0      ,collisions       :0
  Dropped packet events (due to lack of resources):0
  Packets received according to length (in octets):
  64     :644      ,  65-127  :518       ,  128-255  :688
  256-511:101      ,  512-1023:3         ,  1024-1518:0
```

NTP

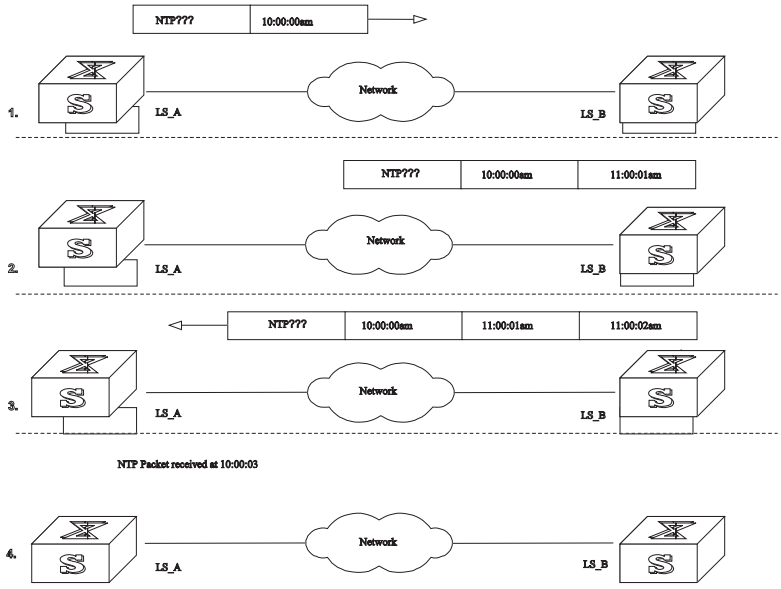
As the network topology gets more and more complex, it becomes important to synchronize the clocks of the equipment on the entire network. Network Time Protocol (NTP) is a TCP/IP feature that advertises the accurate time throughout the network.

NTP ensures the consistency of the following applications:

- Synchronizing the clock between two systems for incremental backup between the backup server and client.
- Referencing the same clock and guaranteeing correct processing for multiple systems that coordinate to process a complex event.
- Guaranteeing the normal operation of the inter-system (Remote Procedure Call).
- Recording an application when a user logs into a system, a file is modified, or some other operation is performed.

Figure 7 illustrates the basic operating principle of NTP:

Figure 7 Basic Operating Principle of NTP



In page 334, Switch A and Switch B are connected to the Ethernet port. They have independent system clocks. Before implementing automatic clock synchronization on both switches, we assume that:

- Before synchronizing the system clocks on Switch A and B, the clock on Switch A is set to 10:00:00am, and the clock on B is set to 11:00:00am.
- Switch B serves as an NTP time server and Switch A synchronizes the local clock with the clock of B.
- It takes 1 second to transmit a data packet from either A or B to the opposite end.

The system clocks are synchronized as follows:

- Switch A sends an NTP packet to Switch B. The packet carries the timestamp 10:00:00am (T1) that tells when it left Switch A.
- When the NTP packet arrives at Switch B, Switch B adds a local timestamp 11:00:01am (T2) to it.
- When the NTP packet leaves Switch B, Switch B adds another local timestamp 11:00:02am (T3) to it.
- When Switch A receives the acknowledgement packet, it adds a new timestamp 10:00:03am (T4) to it.

Next, E Switch A collects enough information to calculate the following two important parameters:

- The delay for a round trip of an NTP packet traveling between the Switch A and B: Delay= (T4-T1) - (T3-T2).
- Offset of Switch A clock relative to Switch B clock: offset= ((T2-T1) + (T3-T4)) /2.

Switch A uses this information to set the local clock and to synchronize it with the clock on Switch B.

Configuring NTP is described in the following sections:

- Configuring NTP
- NTP Configuration Examples

Configuring NTP

NTP configuration includes the tasks described in the following sections:

- Configuring NTP Operating Mode
- Configuring NTP ID Authentication
- Setting the NTP Authentication Key
- Setting the Specified Key to Be Reliable
- Designating an Interface to Transmit the NTP Message
- Setting the NTP Master Clock
- Enabling or Disabling an Interface to Receive an NTP Message
- Setting the Authority to Access a Local Switch
- Setting Maximum Local Sessions
- Displaying and Debugging NTP

Configuring NTP Operating Mode

The Switch 8800 can only serve as an NTP client but not as an NTP server.

You can set the NTP operating mode of the Switch 8800 according to its location in the network, and the network structure. For example, you can set a remote server as the time server of the local equipment. In this case the local Switch 8800 works as an NTP client. If you set a remote server as a peer of the local Switch 8800, the local equipment operates in symmetric active mode. If you configure an interface on the local switch to transmit NTP broadcast packets, the local switch will operate in broadcast mode. If you configure an interface on the local switch to receive NTP broadcast packets, the local switch will operate in broadcast client mode. If you configure an interface on the local switch to transmit NTP multicast packets, the local switch will operate in multicast mode. You may also configure an interface on the local switch to receive NTP multicast packets, the local switch will operate in multicast client mode.

The following sections describe how to configure NTP modes:

- Configuring NTP Server Mode
- Configuring NTP Peer Mode
- Configuring NTP Broadcast Server Mode
- Configuring NTP Broadcast Client Mode
- Configuring NTP Multicast Server Mode
- Configuring NTP Multicast Client Mode

Configuring NTP Server Mode Set a remote server whose IP address is *ip-address* as the local time server. *ip-address* specifies a host address other than a

broadcast, multicast, or reference clock IP address. In this case, the local switch operates in client mode. In this mode, only the local client synchronizes its clock with the clock of the remote server, while the reverse synchronization will not happen.

Perform the following configurations in system view.

Table 64 Configuring NTP Time Server

Operation	Command
Configure NTP time server	**ntp-service unicast-server** *ip-address* [**version** *number* | **authentication-keyid** *keyid* | **source-interface** { *interface-name* | *interface-type interface-number* } | **priority**]*
Cancel NTP server mode	**undo ntp-service unicast-server** *ip-address*

NTP version number *number* ranges from 1 to 3 and defaults to 3; the authentication key ID *keyid* ranges from 0 to 4294967295; *interface-name* or *interface-type interface-number* specifies the IP address of an interface, from which the source IP address of the NTP packets sent from the local switch to the time server will be taken; **priority** indicates the time server will be the first choice.

Configuring NTP Peer Mode Set a remote server whose IP address is *ip-address* as the peer of the local equipment. In this case, the local equipment operates in symmetric active mode. *ip-address* specifies a host address other than a broadcast, multicast, or reference clock IP address. In this mode, both the local switch and the remote server can synchronize their clocks with the clock of the opposite end.

Perform the following configurations in system view.

Table 65 Configuring NTP Peer Mode

Operation	Command
Configure NTP peer mode	**ntp-service unicast-peer** *ip-address* [**version** *number* | **authentication-key** *keyid* | **source-interface** { *interface-name* | *interface-type interface-number* } | **priority**]*
Cancel NTP peer mode	**undo ntp-service unicast-peer** *ip-address*

NTP version number *number* ranges from 1 to 3 and defaults to 3; the authentication key ID *keyid* ranges from 1 to 4294967295; *interface-name* or *interface-type interface-number* specifies the IP address of an interface, from which the source IP address of the NTP packets sent from the local switch to the peer will be taken; **priority** indicates that the peer will be the first choice for time server.

Configuring NTP Broadcast Server Mode Designate an interface on the local switch to transmit NTP broadcast packets. In this case, the local equipment operates in broadcast mode and serves as a broadcast server to broadcast messages to its clients regularly.

Perform the following configurations in VLAN interface view.

Table 66 Configuring NTP Broadcast Server Mode

Operation	Command
Configure NTP broadcast server mode	**ntp-service broadcast-server** [**authentication-keyid** *keyid*] [**version** *number*]
Cancel NTP broadcast server mode	**undo ntp-service broadcast-server**

NTP version number *number* ranges from 1 to 3 and defaults to 3; the authentication key ID *keyid* ranges from 0 to 4294967295. This command can only be configured on the interface where the NTP broadcast packets will be transmitted.

Configuring NTP Broadcast Client Mode Designate an interface on the local switch to receive NTP broadcast messages and operate in broadcast client mode. The local switch listens to the broadcast from the server. When it receives the first broadcast packets, it starts a brief client/server mode to switch messages with a remote server for estimating the network delay. Thereafter, the local switch enters broadcast client mode and continues listening to the broadcast, and synchronizes the local clock according to the arrived broadcast message.

Perform the following configurations in VLAN interface view.

Table 67 Configuring NTP Broadcast Client Mode

Operation	Command
Configure NTP broadcast client mode	**ntp-service broadcast-client**
Disable NTP broadcast client mode	**undo ntp-service broadcast-client**

This command can only be configured on the interface where the NTP broadcast packets are received.

Configuring NTP Multicast Server Mode Designate an interface on the local switch to transmit NTP multicast packets. In this case, the local equipment operates in multicast mode and serves as a multicast server to multicast messages to its clients regularly.

Perform the following configurations in VLAN interface view.

Table 68 Configuring NTP Multicast Server Mode

Operation	Command
Configure NTP multicast server mode	**ntp-service multicast-server** [*ip-address*] [**authentication-keyid** *keyid*] [**ttl** *ttl-number*] [**version** *number*]
Cancel NTP multicast server mode	**undo ntp-service multicast-server**

NTP version number *number* ranges from 1 to 3 and defaults to 3; the authentication key ID *keyid* ranges from 0 to 4294967295; *ttl-number* of the multicast packets ranges from 1 to 255; And the multicast IP address defaults to 224.0.1.1.

This command can only be configured on the interface where the NTP multicast packet is transmitted.

Configuring NTP Multicast Client Mode Designate an interface on the local switch to receive NTP multicast messages and operate in multicast client mode. The local switch listens to the multicast from the server. When it receives the first multicast packets, it starts a brief client/server mode to switch messages with a remote server for estimating the network delay. Thereafter, the local switch enters multicast client mode and continues listening to the multicast and synchronizes the local clock by the arrived multicast message.

Perform the following configurations in VLAN interface view.

Table 69 Configuring NTP Multicast Client Mode

Operation	Command
Configure NTP multicast client mode	**ntp-service multicast-client** [*ip-address*]
Cancel NTP multicast client mode	**undo ntp-service multicast-client**

Multicast IP address *ip-address* defaults to 224.0.1.1. This command can only be configured on the interface where the NTP multicast packets is received.

Configuring NTP ID Authentication

Enable NTP authentication, set the MD5 authentication key, and specify the reliable key. A client will synchronize itself by a server only if the server can provide a reliable key.

Perform the following configurations in system view.

Table 70 Configuring NTP Authentication

Operation	Command
Enable NTP authentication	**ntp-service authentication enable**
Disable NTP authentication	**undo ntp-service authentication enable**

Setting the NTP Authentication Key

This configuration task sets the NTP authentication key.

Perform the following configurations in system view.

Table 71 Configuring the NTP Authentication Key

Operation	Command
Configure the NTP authentication key	**ntp-service authentication-keyid** *number* **authentication-mode md5** *value*
Remove the NTP authentication key	**undo ntp-service authentication-keyid** *number*

Key number *number* ranges from 1 to 4294967295; the key *value* contains 1 to 32 ASCII characters.

Setting the Specified Key to Be Reliable

This configuration task is to set the specified key as reliable.

Perform the following configurations in system view.

Table 72 Setting the Specified Key as Reliable

Operation	Command
Set the specified key as reliable	**ntp-service reliable authentication-keyid** *key-number*
Cancel the specified reliable key.	**undo ntp-service reliable authentication-keyid** *key-number*

Key number *key-number* ranges from 1 to 4294967295

Designating an Interface to Transmit the NTP Message

If the local equipment is configured to transmit all NTP messages, these packets have the same source IP address, which is taken from the IP address of the designated interface.

Perform the following configurations in system view.

Table 73 Designating an Interface to Transmit NTP Message

Operation	Command
Designate an interface to transmit NTP message	**ntp-service source-interface** { *interface-name* | *interface-type interface-number* }
Cancel the interface to transmit NTP message	**undo ntp-service source-interface**

An interface is specified by *interface-name* or *interface-type interface-number*. The source address of the packets will be taken from the IP address of the interface. If the **ntp-service unicast-server** or **ntp-service unicast-peer** command also designates a transmitting interface, use the one designated by them.

Setting the NTP Master Clock

This configuration task sets the external reference clock or the local clock as the NTP master clock.

Perform the following configurations in system view.

Table 74 Setting the External Reference Clock or the Local Clock as the NTP Master Clock

Operation	Command
Set the external reference clock or the local clock as the NTP master clock.	**ntp-service refclock-master** [*ip-address*] [*stratum*]
Cancel the NTP master clock settings	**undo ntp-service refclock-master** [*ip-address*]

ip-address specifies the IP address 127.127.1.u of a reference clock, in which *u* ranges from 0 to 3. *stratum* specifies how many strata the local clock belongs to and ranges from 1 to 15. If no IP address is specified, the system defaults to setting the local clock as the NTP master clock. You can specify the *stratum* parameter.

Enabling or Disabling an Interface to Receive an NTP Message

This configuration task enables or disables an interface to receive the NTP message.

Perform the following configurations in VLAN interface view.

Table 75 Enabling or Disabling an Interface to Receive an NTP Message

Operation	Command
Enable an interface to receive an NTP message	**undo ntp-service in-interface disable**
Disable an interface from receiving an NTP message	**ntp-service in-interface disable**

This configuration task must be performed on the interface to be disabled from receiving an NTP message.

Setting the Authority to Access a Local Switch

Set the authority to access the NTP services on a local switch. This is a basic and brief security measure. An access request will be matched with **peer**, **serve**, **serve only**, and **query only** in an ascending order of the limitation. The first matched authority will be granted.

Perform the following configurations in system view.

Table 76 Setting the Authority to Access a Local Switch

Operation	Command
Set authority to access a local Ethernet switch	**ntp-service access** { **query** | **synchronization** | **serve** | **peer** } *acl-number*
Cancel settings of the authority to access a local Ethernet switch	**undo ntp-service access** { **query** | **synchronization** | **serve** | **peer** }

IP address ACL number is specified through the *acl-number* parameter and ranges from 2000 to 2999. The meanings of other authority levels are as follows:

- **query**: Allow control query for the local NTP service only.
- **synchronization**: Allow request for local NTP time service only.
- **serve**: Allow local NTP time service request and control query. However, the local clock will not be synchronized by a remote server.
- **peer**: Allow local NTP time service request and control query. And the local clock will also be synchronized by a remote server.

Setting Maximum Local Sessions

This configuration task sets the maximum local sessions.

Perform the following configurations in system view.

Table 77 Setting the Maximum Local Sessions

Operation	Command
Set the maximum local sessions	**ntp-service max-dynamic-sessions** *number*
Resume the maximum number of local sessions	**undo ntp-service max-dynamic-sessions**

number specifies the maximum number of local sessions, ranges from 0 to 100, and defaults to 100.

Displaying and Debugging NTP

After completing the previous configurations, you can use the **display** command to show how NTP runs and verify the configurations according to the outputs. You can use the **debugging** command, in user view, to debug NTP. See Table 78 for the details of these commands.

Table 78 Displaying and Debugging NTP

Operation	Command
Display the status of NTP service	**display ntp-service status**
Display the status of sessions maintained by NTP service	**display ntp-service sessions [verbose]**
Display the brief information about every NTP time server on the way from the local equipment to the reference clock source.	**display ntp-service trace**
Debug NTP	**debugging ntp-service**

NTP Configuration Examples

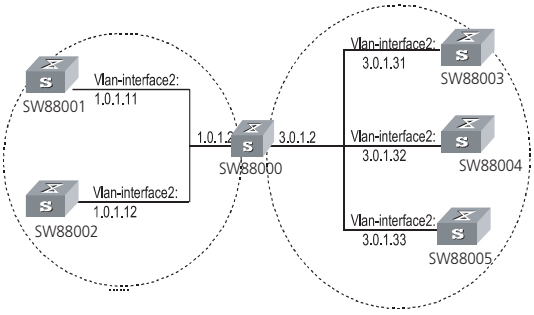
NTP configuration examples are shown in the following:

- Configuring NTP Servers
- Configuring NTP Peers
- Configuring NTP Broadcast Mode
- Configuring NTP Multicast Mode
- Configuring Authentication-Enabled NTP Server Mode

Configuring NTP Servers

On SW88001, set the local clock as the NTP master clock at stratum 2. On SW88002, configure SW88001 as the time server in server mode and set the local equipment as in client mode.

Figure 8 Typical NTP Configuration Networking Diagram



Configure the Switch SW88001:

1 Enter system view.

```
<SW88001> system-view
```

2 Set the local clock as the NTP master clock at stratum 2.

```
[SW88001]ntp-service refclock-master 2
```

Configure Switch SW88002:

1 Enter system view.

```
<SW88002> system-view
```

2 Set SW88001 as the NTP server.

```
[SW88002]ntp-service unicast-server 1.0.1.11
```

The above examples synchronized SW88002 by SW88001. Before the synchronization, the SW88002 is shown in the following status:

```
[SW88002]display ntp-service status

clock status: unsynchronized

 clock stratum: 16

 reference clock ID: none

 nominal frequency: 100.0000 Hz

 actual frequency: 100.0000 Hz

 clock precision: 2^17

 clock offset: 0.0000 ms

 root delay: 0.00 ms

 root dispersion: 0.00 ms

 peer dispersion: 0.00 ms

 reference time: 00:00:00.000 UTC Jan 1 1900(00000000.00000000)
```

After the synchronization, SW88002 turns into the following status:

```
[SW88002]display ntp-service status

clock status: synchronized

 clock stratum: 8

 reference clock ID: LOCAL(0)

 nominal frequency: 100.0000 Hz

 actual frequency: 100.0000 Hz

 clock precision: 2^17

 clock offset: 0.0000 ms

 root delay: 0.00 ms

 root dispersion: 10.94 ms
```

```
 peer dispersion: 10.00 ms

 reference time: 20:54:25.156 UTC Mar 7 2002(C0325201.2811A112)
```

By this time, SW88002 has been synchronized by SW88001 and is at stratum 3, higher than SW88001 by 1.

Display the sessions of SW88002 and you will see SW88002 has been connected with SW88001.

```
[SW88002]display ntp-service sessions

   source          reference       stra reach poll  now offset  delay
disper

**************************************************************************
****** [12345]127.127.1.0     LOCAL(0)           7   377   64   57
0.0    0.0    1.0

    [5]1.0.1.11        0.0.0.0           16     0   64    -    0.0
0.0    0.0

    [5]128.108.22.44   0.0.0.0           16     0   64    -    0.0
0.0    0.0

note: 1 source(master),2 source(peer),3 selected,4 candidate,5
configured
```

Configuring NTP Peers

On SW88003, set local clock as the NTP master clock at stratum 2. On SW88002, configure SW88001 as the time server in server mode and set the local equipment as in client mode. At the same time, SW88005 sets SW88004 as its peer. See Figure 3-3.

Configure Switch SW88003:

1 Enter system view.

```
<SW88003> system-view
```

2 Set the local clock as the NTP master clock at stratum 2.

```
[SW88003]ntp-service refclock-master 2
```

Configure Switch SW88004:

1 Enter system view.

```
<SW88004> system-view
```

2 Set SW88001 as the NTP server at stratum 3 after synchronization.

```
[SW88004]ntp-service unicast-server 3.0.1.31
```

Configure Switch SW88005: (SW88004 has been synchronized by SW88003)

1 Enter system view.

```
<SW88005> system-view
```

2 Set the local clock as the NTP master clock at stratum 1.

```
[SW88005]ntp-service refclock-master 1
```

3 After performing local synchronization, set SW88004 as a peer.

```
[SW88005]ntp-service unicast-peer 3.0.1.32
```

The above examples configure SW88004 and SW88005 as peers and configure SW88005 as in active peer mode and SW88004 in passive peer mode. Since SW88005 is at stratum 1 and SW88004 is at stratum 3, synchronize SW88004 by SW88005.

After synchronization, SW88004 status is shown as follows:

```
[SW88004]display ntp-service status

clock status: synchronized

 clock stratum: 8

 reference clock ID: LOCAL(0)

 nominal frequency: 100.0000 Hz

 actual frequency: 100.0000 Hz

 clock precision: 2^17

 clock offset: 0.0000 ms

 root delay: 0.00 ms

 root dispersion: 10.94 ms

 peer dispersion: 10.00 ms

 reference time: 20:54:25.156 UTC Mar 7 2002(C0325201.2811A112)
```

By this time, SW88004 has been synchronized by SW88005 and it is at stratum 2, or higher than SW88005 by 1.

Display the sessions of SW88004 and you will see SW88004 has been connected with SW88005.

```
[SW88004]display ntp-service sessions

   source          reference       stra reach poll  now offset  delay
disper

**************************************************************************
****** [12345]127.127.1.0     LOCAL(0)          7   377   64   57
0.0    0.0    1.0

    [5]1.0.1.11        0.0.0.0          16     0   64    -    0.0
0.0    0.0

    [5]128.108.22.44   0.0.0.0          16     0   64    -    0.0
0.0    0.0
```

```
note: 1 source(master),2 source(peer),3 selected,4 candidate,5
configured
```

Configuring NTP Broadcast Mode

On SW88003, set local clock as the NTP master clock at stratum 2, and configure to broadcast packets from Vlan-interface2. Configure SW88004 and SW88001 to listen to the broadcast from their Vlan-interface2. See Figure 1-2.

Configure Switch SW88003:

1 Enter system view.

```
<SW88003> system-view
```

2 Set the local clock as the NTP master clock at stratum 2.

```
[SW88003]ntp-service refclock-master 2
```

3 Enter Vlan-interface2 view.

```
[SW88003]interface vlan-interface 2
```

4 Set it as broadcast server.

```
[SW88003-Vlan-Interface2]ntp-service broadcast-server
```

Configure Switch SW88004:

1 Enter system view.

```
<SW88004> system-view
```

2 Enter Vlan-interface2 view.

```
[SW88004]interface vlan-interface 2
[SW88004-Vlan-Interface2]ntp-service broadcast-client
```

Configure Switch SW88001:

1 Enter system view.

```
<SW88001> system-view
```

2 Enter Vlan-interface2 view.

```
[SW88001]interface vlan-interface 2
[SW88001-Vlan-Interface2]ntp-service broadcast-client
```

The above examples configured SW88004 and SW88001 to listen to the broadcast through Vlan-interface2, SW88003 to broadcast packets from Vlan-interface2. Since SW88001 and SW88003 are not located on the same segment, they cannot receive any broadcast packets from SW88003, while SW88004 is synchronized by SW88003 after receiving its broadcast packet.

After the synchronization, you can find the state of SW88004 as follows:

```
[SW88004]display ntp-service status

clock status: synchronized

 clock stratum: 8

 reference clock ID: LOCAL(0)

 nominal frequency: 100.0000 Hz
```

```
 actual frequency: 100.0000 Hz

 clock precision: 2^17

 clock offset: 0.0000 ms

 root delay: 0.00 ms

 root dispersion: 10.94 ms

 peer dispersion: 10.00 ms

 reference time: 20:54:25.156 UTC Mar 7 2002(C0325201.2811A112)
```

By this time, SW88004 has been synchronized by SW88003 and it is at stratum 3, higher than SW88003 by 1.

Display the status of SW88004 sessions and you will see SW88004 has been connected to SW88003:

```
[SW88002]display ntp-service sessions

   source          reference       stra reach poll  now offset  delay
disper

**************************************************************************
****** [12345]127.127.1.0     LOCAL(0)          7   377   64   57
0.0    0.0    1.0

    [5]1.0.1.11        0.0.0.0           16     0   64    -    0.0
0.0    0.0

    [5]128.108.22.44   0.0.0.0           16     0   64    -    0.0
0.0    0.0

note: 1 source(master),2 source(peer),3 selected,4 candidate,5
configured
```

Configuring NTP Multicast Mode

SW88003 sets the local clock as the master clock at stratum 2, and multicast packets from Vlan-interface2. Set SW88004 and SW88001 to receive multicast messages from their respective Vlan-interface2. See Figure 1-2.

Configure Switch SW88003:

1. Enter system view.

   ```
   <SW88003> system-view
   ```

2. # Set the local clock as a master NTP clock at stratum 2.

   ```
   [SW88003]ntp-service refclock-master 2
   ```

3. Enter Vlan-interface2 view.

   ```
   [SW88003]interface vlan-interface 2
   ```

4. Set it as a multicast server.

   ```
   [SW88003-Vlan-Interface2]ntp-service multicast-server
   ```

Configure Switch SW88004:

1 Enter system view.

```
<SW88004> system-view
```

2 Enter Vlan-interface2 view.

```
[SW88004]interface vlan-interface 2
```

3 Enable multicast client mode.

```
[SW88004-Vlan-Interface2]ntp-service multicast-client
```

Configure Switch SW88001:

1 Enter system view.

```
<SW88001> system-view
```

2 Enter Vlan-interface2 view.

```
[SW88001]interface vlan-interface 2
```

3 Enable multicast client mode.

```
[SW88001-Vlan-Interface2]ntp-service multicast-client
```

The above examples configure SW88004 and SW88001 to receive multicast messages from Vlan-interface2, SW88003 multicast messages from Vlan-interface2. Since SW88001 and SW88003 are not located on the same segments, SW88001 cannot receive the multicast packets from SW88003, while SW88004 is synchronized by SW88003 after receiving the multicast packet.

Configuring Authentication-Enabled NTP Server Mode

SW88001 sets the local clock as the NTP master clock at stratum 2. SW88002 sets SW88001 as its time server in server mode and itself in client mode and enables authentication. See Figure 1-2.

Configure Switch SW88001:

1 Enter system view.

```
<SW88001> system-view
```

2 Set the local clock as the master NTP clock at stratum 2.

```
[SW88001]ntp-service refclcok-master 2
```

Configure Switch SW88002:

1 Enter system view.

```
<SW88002> system-view
```

2 Set SW88001 as time server.

```
[SW88002]ntp-service unicast-server 1.0.1.11
```

3 Enable authentication.

```
[SW88002]ntp-service authentication enable
```

4 Set the key.

```
[SW88002]ntp-service authentication-keyid 42 authentication-mode md5
aNiceKey
```

5 Set the key as reliable.

```
[SW88002]ntp-service reliable authentication-keyid 42
```

The above examples synchronized SW88002 by SW88001. Since SW88001 has not been enabled authentication, it cannot synchronize SW88002.

Perform the following additional configurations on SW88001:

1. Enable authentication.

```
[SW88001]ntp-service authentication enable
```

2. Set the key.

```
[SW88001]ntp-service authentication-keyid 42 authentication-mode md5
aNiceKey
```

3. Configure the key as reliable.

```
[SW88001]ntp-service reliable authentication-keyid 42
```